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VOLUME XX.

CONTAINING

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THE TRILOBITES OF THE SILURIAN, DEVONIAN, &c., FORMATIONS. Part IV (SILURIAN). By Mr. J. W. SALTER. Six Plates.

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ISSUED FOR 1866.

JUNE, 1867.

LIST

OF

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AND

A CATALOGUE OF THE WORKS ALREADY PUBLISHED; A CLASSIFIED LIST OF THE
MONOGRAPHS COMPLETED AND IN PREPARATION, WITH THE NAMES OF THEIR
RESPECTIVE AUTHORS; THE DATES OF ISSUE OF THE ANNUAL VOLUMES;
AND A GENERAL SUMMARY SHOWING THE NUMBER OF
THEIR PAGES, PLATES, AND FIGURES, AND
OF THE SPECIES ILLUSTRATED
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- „ XIX. „ 1865 { The Crag Foraminifera, Part I, No. 1, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, 4 plates.
Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan, 10 plates.
The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward, 9 plates.
The Fossil Brachiopoda, Part VII, No. 1, Silurian, by Mr. Davidson, 12 plates.
- „ XX. „ 1866 { Supplement to the Fossil Corals, Part IV, No. 1, Liassic, by Dr. Duncan, 11 plates.
The Trilobites of the Silurian, Devonian, &c., Formations, Part IV (Silurian), by Mr. J. W. Salter, 6 plates.
The Fossil Brachiopoda, Part VII, No. 2, Silurian, by Mr. Davidson, 10 plates.
The Belemnitidæ, Part III, Liassic Belemnites, by Prof. Phillips, 13 plates.

LIST OF MONOGRAPHS

Completed, in Preparation, and in course of Publication.*

MONOGRAPHS which have been COMPLETED :—

- The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime.
- The Tertiary Echinodermata, by Professor Forbes.
- The Fossil Cirripedes, by Mr. C. Darwin.
- The Tertiary Entomostraca, by Prof. T. Rupert Jones.
- The Cretaceous Entomostraca, by Prof. T. Rupert Jones.
- The Fossil Estheriæ, by Prof. T. Rupert Jones.
- The Polyzoa of the Crag, by Mr. G. Busk.
- The Tertiary, Cretaceous, Oolitic, Liassic, Permian, Carboniferous, and Devonian Brachiopoda, by Mr. T. Davidson.
- The Mollusca of the Crag, by Mr. S. V. Wood.
- The Great Oolite Mollusca, by Professor Morris and Mr. J. Lycett.
- The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe.
- The Fossils of the Permian Formation, by Professor King.
- The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), by Professors Owen and Bell.
- The Reptilia of the Cretaceous, Wealden, and Purbeck Formations, by Professor Owen.

MONOGRAPHS which are in course of PREPARATION :*—

- The Flora of the Tertiary Formation, by Mr. W. S. Mitchell.
- The Flora of the Carboniferous Formation, by Mr. E. W. Binney.
- The Cretaceous Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.

* Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

MONOGRAPHS in course of PREPARATION—*Continued.*

- The Foraminifera of the Lias, by Mr. H. B. Brady.
 The Graptolites, by Professor Wyville Thomson.
 The Crinoidea, by Professor Wyville Thomson.
 The Post-Tertiary Entomostraca, by the Rev. H. W. Crosskey and Messrs. G. S. Brady and D. Robertson.
 The Wealden, Purbeck, and Jurassic Entomostraca, by Messrs. T. Rupert Jones and G. S. Brady.
 The Bivalve Entomostraca of the Carboniferous Formation, by Messrs. T. Rupert Jones and J. W. Kirkby.
 The Phyllopoda of the Palæozoic Rocks, by Mr. J. W. Salter.
 The Polyzoa of the Chalk Formation, by Mr. G. Busk.
 The Post-Tertiary Mollusca, by Mr. J. Gwyn Jeffreys.
 The Cretaceous Mollusca (exclusive of the Brachiopoda), by the Rev. T. Wiltshire.
 The Purbeck Mollusca, by Mr. R. Etheridge.
 The Inferior Oolite Mollusca, by Mr. R. Etheridge.
 The Rhætic Mollusca, by Mr. R. Etheridge.
 The Liassic Gasteropoda, by Mr. Ralph Tate.
 The Ammonites of the Lias, by Dr. Wright.
 The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester.
 The Crag Cetacea, by Professor Owen.
-

MONOGRAPHS in course of PUBLICATION :—

- The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.
 Supplement to the Fossil Corals, by Dr. Duncan.
 The Echinodermata of the Oolitic and Cretaceous Formations, by Dr. Wright.
 The Fossil Merostomata, by Mr. H. Woodward.
 The Trilobites of the Mountain-Limestone, Devonian, and Silurian Formations, by Mr. J. W. Salter.
 The Eocene Mollusca, by Messrs. F. E. Edwards and S. V. Wood.
 The Silurian Brachiopoda, by Mr. Davidson.
 The Belemnites, by Professor Phillips.
 The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.
 The Reptilia of the Liassic Formations, by Professor Owen.

Dates of the Issue of the Yearly Volumes of the Palæontographical Society.

The Volume for 1847 was issued to the Members, March, 1848.

	1848	„	„	„	July, 1849.
„	1849	„	„	„	August, 1850.
„	1850	„	„	„	June, 1851.
„	1851	„	„	„	June, 1851.
„	1852	„	„	„	August, 1852.
„	1853	„	„	„	December, 1853.
„	1854	„	„	„	May, 1855.
„	1855	„	„	„	February, 1857.
„	1856	„	„	„	April, 1858.
„	1857	„	„	„	November, 1859.
„	1858	„	„	„	March, 1861.
„	1859	„	„	„	December, 1861.
„	1860	„	„	„	May, 1863.
„	1861	„	„	„	May, 1863.
„	1862	„	„	„	August, 1864.
„	1863	„	„	„	June, 1865.
„	1864	„	„	„	April, 1866.
„	1865	„	„	„	December, 1866.
„	1866	„	„	„	June, 1867.

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (up to JUNE, 1867) : showing in the first column whether each Monograph hitherto published be complete, or, in the course of completion ; in the second column, the yearly volumes which contain each particular Monograph as a guide to binding the same ; and in the fifth and following columns, the number of pages, plates, figures, and species described in the different Monographs.

I.
SUBJECT OF MONOGRAPH.

I.		II.		III.		IV.		V.		VI.		VII.		VIII.	
SUBJECT OF MONOGRAPH.		Dates of the Years for which the Volume was issued.		Dates of the parts of publication, and the page of each part.		Dates of the parts of publication, and the page of each part.		No. of Plates Monograph.		No. of Pages in each Monograph.		No. of Figures and Woodcuts.		No. of Species in the Test.	
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, in course of completion.															
Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, <i>complete</i> (2).		1865	1865	1865	1865	1865	1865	78	4	406	72	211	43	43	43
Supplement to the Fossil Corals, by Dr. Duncan, in course of completion.		1849, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1854	1866	1866	1866	1866	1866	1866	1866	1866
The Polyzoa of the Crag, by Mr. G. Bask, <i>complete</i> .		1865, 1866	1865, 1866	1865, 1867	1865, 1867	1865, 1867	1865, 1867	114	21	375	74	375	74	74	74
The Tertiary Echinodermata, by Prof. Forbes, <i>complete</i> .		1857	1857	1857	1857	1857	1857	145	22	641	122	641	122	122	122
The Oolitic Echinodermata, by Dr. Wright. Vol. I, <i>complete</i> .		1855, 1856, 1857, 1858	1855, 1856, 1857, 1858	1855, 1856, 1857, 1858	1855, 1856, 1857, 1858	1855, 1856, 1857, 1858	1855, 1856, 1857, 1858	39	4	144	44	144	44	44	44
The Oolitic Echinodermata, Vol. II, in course of completion.		1861, 1864	1861, 1864	1861, 1864	1861, 1864	1861, 1864	1861, 1864	474	43	724	218	724	218	218	218
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, in course of completion.		1862	1862	1862	1862	1862	1862	64	11	192	13	192	13	13	13
The Fossil Cirripedes, by Mr. C. Darwin, <i>complete</i> .		1851, 1854, 1855a	1851, 1854, 1855a	1851, 1854, 1855*	1851, 1854, 1855*	1851, 1854, 1855*	1851, 1854, 1855*	137	7	320	54	320	54	54	54
The Fossil Merostomata, by Mr. H. Woodward, in course of completion.		1865	1865	1866	1866	1866	1866	44	9	50	1	50	1	1	1
The Tertiary Entomostraca, by Prof. Rupert Jones, <i>complete</i> .		1855	1855	1856	1856	1856	1856	74	6	233	56	233	56	56	56
The Fossil Eutherozoa, by Prof. Rupert Jones, <i>complete</i> .		1849	1849	1849	1849	1849	1849	41	7	176	27	176	27	27	27
The Trilobites of the Mountain-limestones, Devonian, Silurian, and other Formations, by Prof. W. Saltzer, in course of completion.		1860	1860	1862	1862	1862	1862	139	5	158	19	158	19	19	19
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1862, 1863, 1864, 1866	1862, 1863, 1864, 1866	1864, 1865, 1866, 1867	1864, 1865, 1866, 1867	1864, 1865, 1866, 1867	1864, 1865, 1866, 1867	216	31	703	114	703	114	114	114
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1866, 1860	1866, 1860	1867, 1862	1867, 1862	1867, 1862	1867, 1862	86	22	215	50	215	50	50	50
Fossil Brachiopoda, Vol. I. The Tertiary Cretaceous Oolitic Silurian Devonian Permian and Carboniferous Brachiopoda, by Mr. F. Davidson, <i>complete</i> .		1850, 1852, 1853, 1854	1851, 1852, 1853, 1854	1851, 1852, 1853, 1854	1851, 1852, 1853, 1854	1851, 1852, 1853, 1854	1851, 1852, 1853, 1854	409	42	1855	160	1855	160	160	160
Fossil Brachiopoda, Vol. II. The Permian and Carboniferous Brachiopoda, by Mr. F. Davidson, <i>complete</i> .		1856, 1857, 1858, 1859, 1860	1856, 1857, 1858, 1859, 1860	1857, 1858, 1859, 1860	1857, 1858, 1859, 1860	1857, 1858, 1859, 1860	1857, 1858, 1859, 1860	331	59	1909	137	1909	137	137	137
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1862, 1863, 1865, 1866	1862, 1863, 1865, 1866	1864, 1865, 1866, 1867	1864, 1865, 1866, 1867	1864, 1865, 1866, 1867	1864, 1865, 1866, 1867	259	42	1551	185	1551	185	185	185
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1847, 1855b	1847, 1855b	1848	1848	1848	1848	216	21	581	244	581	244	244	244
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1850, 1852, 1853, 1854	1850, 1852, 1853, 1854	1850, 1853, 1856, 1860	1850, 1853, 1856, 1860	1851, 1853, 1857, 1861	1851, 1853, 1857, 1861	344	31	691	263	691	263	263	263
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1849, 1852, 1854, 1855	1849, 1852, 1854, 1855	1849, 1852, 1854, 1856	1849, 1852, 1854, 1856	1849, 1852, 1855, 1857	1849, 1852, 1855, 1857	382	30	961	161	961	161	161	161
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1850	1850	1850	1850	1850	1850	322	20	396	146	396	146	146	146
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1850, 1853, 1854	1850, 1853, 1854	1850, 1853, 1854	1850, 1853, 1854	1850, 1853, 1855	1850, 1853, 1855	232	30	961	161	961	161	161	161
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1861	1861	1861	1861	1861	1861	129	15	347	104	347	104	104	104
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1863, 1864, 1866	1863, 1864, 1866	1865, 1866, 1867	1865, 1866, 1867	1865, 1866, 1867	1865, 1866, 1867	89	20	383	48	383	48	48	48
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1853, 1854, 1855	1853, 1854, 1855	1853, 1854, 1856	1853, 1854, 1856	1853, 1855, 1857	1853, 1855, 1857	27	319	79	79	79	79	79	79
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1849, 1854, 1856f	1849, 1854, 1856f	1850*	1850*	1850*	1850*	287	27	611	138	611	138	138	138
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1848, 1849, 1856f	1848, 1849, 1856f	1849, 1850*	1849, 1850*	1849, 1850, 1859	1849, 1850, 1859	150	58	304	39	304	39	39	39
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1851, 1857, 1858, 1862	1851, 1857, 1858, 1862	1851, 1859, 1860, 1864	1851, 1859, 1860, 1864	1851, 1859, 1861, 1864	1851, 1859, 1861, 1864	184	59	519	26	519	26	26	26
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1853, 1854, 1856, 1856	1853, 1854, 1856, 1856	1853, 1854, 1856, 1857	1853, 1854, 1856, 1857	1853, 1856, 1857, 1858	1853, 1856, 1857, 1858	155	62	251	17	251	17	17	17
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1857, 1858, 1862	1857, 1858, 1862	1859, 1860, 1864	1859, 1860, 1864	1859, 1861, 1864	1859, 1861, 1864	165	62	251	17	251	17	17	17
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1861, 1862	1861, 1862	1861, 1862	1861, 1862	1861, 1863	1861, 1863	44	19	88	2	88	2	2	2
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1865	1865	1865	1865	1865	1865	40	16	62	5	62	5	5	5
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1866	1866	1866	1866	1866	1866	70	5	43	1	43	1	1	1
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1863	1863	1863	1863	1863	1863	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348	3,348	3,348
The Malacostraca (Crust.) W. Saltzer, in course of completion.		1864	1864	1866	1866	1866	1866	5776	871	16,384	3,348	16,384	3,348		

a Index.

a Index.
b Title-page to Univolveros.

a Many of the species are

Many of the species are described, but not figured.

Wants Index.

Wants Index. m Useful in binding.

100

Notes to China Wallaces

h British enclosures.

	<i>a</i> Contains the Female Note to Crag-Moussa.	<i>b</i> British species only reckoned	<i>c</i> British species
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A MONOGRAPH

OF THE

BRITISH FOSSIL CORALS.

SECOND SERIES.

BY

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SECRETARY TO THE GEOLOGICAL SOCIETY.

Being a Supplement to the

'Monograph of the British Fossil Corals,' by MM. MILNE-EDWARDS and JULES HAIME.

PART IV, No. 1.

CORALS FROM THE ZONES OF AMMONITES PLANORBIS AND AMMONITES
ANGULATUS IN THE LIASSIC FORMATION.

Pages i, ii; 1—43; Plates I—XI.

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A MONOGRAPH
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PART IV. No. 1.

PREFACE.

It was noticed in the Preface to the First Part of this series that some irregularity in the succession of the Monographs would occur. According to the plan adopted by MM. Milne-Edwards and Jules Haime, the Corals of the Cretaceous rocks should have been described in this Part; but it was found advisable to take advantage of Mr. Charles Moore's splendid collection of Liassic Madreporaria, and to describe the species contained in it at once.

MM. Milne-Edwards and Jules Haime only described three species from the whole of the British Lias; and as one was probably a *remanié* fossil,¹ and another could not be determined generically,² only one good species, *Trochocyathus Moorei*, Ed. and H., remained to characterise this great formation.

Since those authors wrote, many careful collectors have found large numbers of Corals in the Middle and Lower Lias; and Dr. Wright,³ the Rev. P. B. Brodie,⁴ and Mr. Ralph Tate,⁵ have published notices and descriptions of species.

Lately Mr. Tawney and the author brought the Corals of the Sutton Stone⁶ before the notice of the Geological Society; and Mr. Charles Moore, who had long before

¹ 'Monograph. Brit. Foss. Cor.,' p. 145, Palæontograph. Soc., 1851.

² Ibid.

³ 'Quart. Journ. Geol. Soc.,' 1857, p. 34.

⁴ 'Reports of the British Association for 1860, Reports of Sections,' p. 73. 'Quart. Journ. Geol. Soc.,' 1860, vol. xvii, p. 151. "A Sketch of the Lias, &c.," 'Transact. Woolhope Nat. Field Club,' No. 1.

⁵ 'Quart. Journ. Geol. Soc.,' vol. xx, p. 111.

⁶ Ibid., vol. xxii, p. 91.

collected Sutton Stone Corals, and had discovered the highly fossiliferous deposit at Brocastle, forwarded me his specimens, which are about to be described. The above-mentioned geologists have afforded me all the information at their command; and Messrs. Kershaw, Winwood, Boyd Dawkins, Burton, Chamberlin, and Mrs. Strickland, have placed me under great obligations.

Finding that at least fifty new species would have to be added to the list of British Liassic Corals, it was thought advisable to publish the most important at once.

This Part of the Second Series will refer to the Corals of that portion of the Lower Lias which intervenes between the Rhætic strata and the beds which contain *Ammonites Bucklandi* (*bisulcatus*) and *Gryphæa incurva* (type) in abundance.¹

The next portion of this Monograph (Part IV, No. 2) will contain the description of the Corals of the other beds of the Lower Lias, and of the forms in the Middle and Upper Liassic deposits. It is probable that several Liassic beds whose geological horizon is not yet determined may yield new species of Corals which will have to be associated with those of the zone of *Ammonites angulatus*, and they will, of necessity, be included in Part IV, No. 2, in which the lists of the species will be given, with a notice of the Corals of the Liassic strata of Continental Europe.

Owing to the paucity of specimens, it is thought advisable to defer the consideration of the species from the White Lias of the Rhætic series and from the Zone of *Avicula contorta* to a future occasion.

¹ Madreporaria of the Infra-Lias of South Wales. P. Martin Duncan, 'Quart. Journ. Geol. Soc.,' Feb., 1867.

A MONOGRAPH OF THE BRITISH FOSSIL CORALS.

(SECOND SERIES.)

PART IV.—No. 1.

INTRODUCTION.

THE Corals contained in the Liassic strata of Britain, France, Germany, and Italy have a very decided community of facies; at the same time it is evident that some portions of the Liassic Coral-fauna resemble Triassic types, and that another portion is allied to the Oolitic.

This was to be expected, for it is evident that the stunted *Thecosmilæ*, and the *Astrocæniæ* of the Zone of *Ammonites angulatus*, are the descendants of the equally stunted *Thecosmilæ* and of the *Astrocæniæ* of the Triassic age. Moreover, the descendants of the *Isastrææ*, and of the larger *Montlivaltia* of the Lower and Middle Lias, luxuriated in the Oolitic seas.

The bulk of the Liassic Coral-fauna is, however, characteristic of and special to the formation; and, as is the case in other great series of strata, certain assemblages of species appear to characterise certain definite geological horizons. Yet not unexceptionably, for some species range into higher zones in certain areas, whilst others, which are confined to a definite horizon in one area, are found below and above the equivalents of the horizon in a distant locality. Thus a species, which is only found in a particular bed, and is associated with a particular molluscan fauna in one locality, may be found to be associated with a molluscan fauna antecedent or posterior in its recognized succession, in another place.

It is this uncertain vertical range of species, this variation in vertical range in different geographical areas, which causes the apparent antagonism of Physical Geology (as applied to Classificatory Geology) and Palæontology.

It is this coming in of the same species at various positions in a large formation and their association with different groups of species that renders Palæontology of more or less uncertain value in the exact determination of the age of strata.

But it is this varying vertical range of species in different areas and their association with different groups of forms that points to an ever-changing life-scene, to migration of faunæ, to changes of physical conditions, to variation in the intensity of competition, to the rise of dominant and the decay of feeble forms, and to all those external agencies which affect the inherent power of variation peculiar to the animated nature of this world, where no two things are exactly alike.

The persistence of a species in a succession of strata, and its consecutive association with different groups of competitors and contemporaries, is constantly observed in the Lias, taken as a whole; and it is the strongest fact that can be adduced against the almost exploded notion of a series of cataclysmal destructions and of successive creations of beings occurring at intervals which are denoted by changes in physical geology. It is necessary to assert that those doctrines are not quite exploded, for they have a deep hold on the minds of many who have only a limited area of geological observation. The disposition to limit the possibility of the occurrence of certain specific forms to definite vertical ranges arises from a partial belief in those ideas, and they are apparently strengthened in the force of their application when physical breaks accompany palæontological changes.

Here the question concerning the physical causes which permit of and assist in the preservation of dead organisms must be considered in reference to those which have a diametrically opposite effect.

If it be admitted that when the terrestrial conditions are *in statu quo* the preservation of organic remains from destruction is hardly possible; that during elevation of areas the entombment and fossilization of organisms is equally unlikely, and that a gradual depression of the surface is in the majority of instances necessary for the preservation of deposits, it becomes evident that, whilst the physical break has a diminished value in its relation to the persistence of the life of species, the existence of a species in a considerable series of strata which could not have all been deposited during a continuous and uninterrupted sinking of their area becomes most suggestive. Taken in combination with the remarks which have preceded, it is suggestive of the evident want of relation between the formation of strata and the origin and decadence of the species of the period; and it points out that no Stratigraphical Palæontogeology can be perfect in a classificatory sense, and that zones of species may have little to do with the notion of time.

With an ever-progressing animated nature there are and have ever been associated terrestrial and inorganic changes. There is no definite connection between them, and hence our classificatory systems have an increment of error which is constantly rising to the surface when the pure physical geologist and the pure palæontologist argue upon their own bases concerning the age of strata.

The notion that the succession of strata all over the world must be upon the same plan as that of the best studied, typical or most familiar district favours this difficulty ; and it is most true that the Lias has been, from the applicability of the foregoing remarks, a very debateable ground.

The relation of the Bone-bed to the Trias ; the propriety of forming a Rhætic series ; its relation to the Trias and Lias ; the possibility of arranging the strata of the Lias in Zones of Ammonite life ; the propriety of including the Liassic strata between the Keuper and the Zone of *Ammonites Bucklandi*, or between the base of the Zone of *Ammonites planorbis* and the Zone of *Ammonites Bucklandi* in a sub-group, calling it Infra-Lias ; the possibility of separating the Zone of *Ammonites Bucklandi* from the Zone of *Ammonites angulatus*, and the impropriety of distinguishing Zones of Cephalopoda, Insecta, Sauria, or Madreporaria—all these have been points debated over and over again, and they will ever be so as long as artificial distinctions are placed “en rapport” with nature.

Nevertheless, carefully collected palæontological data concerning the vertical range of species are gradually deciding many of these questions, and with the effect of isolating the palæontologist more and more in his relations with the received classificatory geology.

These remarks are made because it is necessary to give the various groups of species of *Madreporaria* of the Lias places in some classification or other. It is impossible to associate them with beds determinable on purely stratigraphical or mineralogical data ; and it is equally impossible to include them in Zones of special life, for *Cephalopoda* and *Saurians* are rarely in relation with Corals. The groups of *Madreporaria* have a general relation to certain zones of life and to certain strata ; and if they are associated for the sake of a necessary classification with certain Ammonite-Zones, it must be understood that it is only an approximative classification, and that both the Ammonites and the Madreporaria may range out of their supposed restricted zone, or not even be represented in certain portions of its area.

If it be admitted that by a Zone of an Ammonite or of any other Mollusc the general and usual vertical limit of the species is meant, all the difficulties thrown in the way of the philosophical, but still artificial, separation of the Liassic series into Ammonite-Zones vanish.

Dr. Wright has elaborated this system in his ‘Monograph of the Oolitic Asteriadae,’¹ and had his Zone of *Ammonites angulatus* been known to have been as well developed in Glamorganshire and in Lincolnshire as it is in some of its most typical districts in France, his arrangement would have met with slight opposition. But the endeavour to give definite horizons to and to correlate *Saurian*, *Insect*, *Ostræa*, *Ammonite*, and *Lima* beds has resulted in the production of confusion instead of the reverse.

Whether the principle of the arrangement in ‘Zones of Ammonites is admitted or not, it is absolutely necessary that the foreign equivalents of our Liassic subdivisions should

¹ Pal. Soc.

be studied. If this be done the association of the characteristic species of certain British beds with the characteristic species of a lower geological horizon on the Continent becomes evident, and the unphilosophical nomenclature of geologists who restrict themselves to the study of small areas is exposed.

In classifying the groups of species about to be described, in the geological scale attention will be directed to the Ammonite-Zone in which they are found and to the Mollusca associated with them.

There are a few Triassic species in the Liassic Coral-fauna, and the Branching Corals of the Sutton Stone have, generally speaking, a very Triassic facies. The majority of the Corals of the lowest members of the Lias are peculiarized by the imperfection of their septal arrangement: the distinct development of definite cycles in six systems is rarely observed, and it would appear that this high organization was not attained in the forms which had varied from Palæozoic into Mesozoic species. The *Montlivaltia*, *Thecosmilæ*, and *Astrocænia* of the Lower Lias of Glamorganshire illustrate this remark; and the first definite septal arrangement is met with in the *Montlivaltia Haimeï*, Ch. et Dew, in the Zone of *Ammonites angulatus* at Marton.

The septal number is also very uncertain in the species of the above-mentioned genera in the Lower Lias, and multiseptate *Montlivaltia* are found in the same deposit as those possessing an unusually small number of septal laminæ. It may, in fact, be asserted that the so-called *rugose* peculiarities had hardly left their hold upon Madreporarian life at the time when the lowest members of the Lias were deposited. The genus *Elysastræa*, Laube, retains some "rugose" peculiarities, and the transition from the tabulæ and vesicular endotheca of a *Cyathophyllum* to the dissepiments and vesicular endotheca of some forms of *Montlivaltia polymorpha*, Terq. et Piette, is certainly within the bounds of possibility. Nevertheless, no Palæozoic genera of Corals have been found in the Lias except as "remanic" fossils.

The genera which are represented in those subdivisions of the Lias called the Zones of *Ammonites planorbis* and *Ammonites angulatus* are—

- I. *Montlivaltia*.
- II. *Rhabdophyllia*.
- III. *Thecosmilæ*.
- IV. *Oppelosmilæ*, gen. nov.
- V. *Isastræa*.
- VI. *Astrocænia*.
- VII. *Cyathocænia*, gen. nov.
- VIII. *Elysastræa*.
- IX. *Septastræa*.
- X. *Latimæandra*.

No *Tabulate* nor *Perforate* genera have been discovered; yet as they existed both in palæozoic times, and in formations more recent than the Lias, they doubtlessly will be found.

The multitude of branching *Thecosmilia*, stunted *Montlivaltia*, and small-caliced *Astrocenia*, give the peculiar facies to the Coral-fauna of these members of the Lower Lias.

II. CORALS FROM THE ZONE OF AMMONITES PLANORBIS.

The yellow shale in the section at Street which contains *Ammonites planorbis* and *Ichthyosaurus intermedius* has yielded a large and well-preserved specimen of the genus *Septastræa*.¹ At Binton there are said to be Corals in the "Guinea" bed," but no specimens could be obtained.

SECTION—*APOROSA*.

FAMILY—*ASTRÆIDÆ*.

Division—*FAVIACEÆ*.

Genus—*SEPTASTRÆA*.³

1. *SEPTASTRÆA HAIMEI*, *Wright*, sp. Pl. I, figs. 1—5.

The corallum is massive, tall, club-shaped, and rather gibbous. The shape is generally sub-cylindrical, the base is small and conical, and the top is large and convex.

The calices cover the corallum, are very numerous, and are separated by rather thick and united walls. The calices are irregular in size, shallow, and more or less polygonal; and they have a tendency to elongate at one end, as well as to divide fissiparously.

The septa are irregular in size, shape, and number; they are small, unequal, rather distant, and the only ornamentation is an ill-defined swelling here and there. They are not exsert; the smallest reach but a slight distance from the wall, but the larger occasionally reach the centre of the calice and unite.

Fissiparity is produced by two large septa stretching across the calice and developing others from their sides. The septa vary in number, from thirty to forty, but no cyclical arrangement is distinguishable. The endotheca is rather plentiful.

¹ ² *Wright*, 'Monogr. Oolitic Asteroidea', Pal. Soc., p. 5 and p. 10.

³ 'Hist. Nat. des Corall.', vol. ii.

Height of corallum, 7 inches. Breadth, $4\frac{1}{2}$ inches. Diameter of calices, $\frac{3}{10}$ ths to $\frac{4}{10}$ ths inch.

Locality. Street, Somersetshire. In the Collection of Dr. Wright, F.G.S.

The genus *Septastræa* resembles *Isastræa*; but there is fissiparous growth in the calices of the first, and never in the calices of the last-named genus. The peculiar calicinal gemmation of *Isastræa* never produces septa which, crossing the calice, divide it off into separate individuals. The walls of *Septastræa* are not so perfectly united as in *Isastræa*. The genus is found in the Lias and in the Tertiary Coral-fauna.

The shape of the corallum and the septal structures and arrangement distinguish the species from *Septastræa excavata*,¹ E. de From., and *Septastræa Fromenteli*, Terquem et Piette.

III. CORALS FROM THE ZONE OF AMMONITES ANGULATUS.

The Sutton Stone² and the deposits at Brocastle, Ewenny, and Cowbridge,³ are highly coralliferous beds in Glamorganshire. They rest on the Mountain-limestone, and are covered by members of the Lias higher in the series than the Zone of *Ammonites angulatus*. They have the homotaxis⁴ of the Continental strata, which are classified within the Zones of *Ammonites angulatus* and *Ammonites moreanus*, such as the Calcaire de Valogne, the Foie de Veau, in the Côte d'Or, and the Grès Calcareux, in the Duchy of Luxembourg. Their British equivalent strata are well shown at Marton, near Gainsborough, and in Ireland⁵ near Belfast, besides in the localities mentioned by Dr. Wright.⁶

¹ Dr. Wright named this Coral *Isastræa Haimei*, and noticed its specific distinction from *Isastræa Murchisoni*, Wright. Its genus is evidently *Septastræa*, and although Dr. Wright has not published a specific diagnosis of the form, still it is just that it should retain his name. He is answerable for its discovery in the locality given above.

² Sir Henry de la Beche, 'Mem. Geol. Survey,' vol. i, p. 270; Mr. Tawney, and P. Martin Duncan, 'Quart. Journ. Geol. Soc.,' vol. xxii, p. 69.

³ Mr. Charles Moore discovered the Brocastle and Ewenny deposits some years before Mr. Tawney drew attention to the Sutton Stone. He collected a vast number of fossils from them, and forwarded them to me for examination. His able essay on "Abnormal Conditions of Secondary Deposits," &c., was read before the Geological Society, March 20th, 1867. See my notice of Mr. Chas. Moore's labours, 'Quart. Journ. Geol. Soc.,' Feb. 1867, p. 13. See also "On the Lower Lias or Lias-Conglomerate of a Part of Glamorganshire," by H. W. Bristow, F.R.S.; "On the Zone of *Ammonites angulatus* in Britain," by R. Tate, F.G.S.

⁴ "On the Madreporaria of the Infra-Lias of South Wales," by P. Martin Duncan, 'Quart. Journ. Geol. Soc.,' 1866, Feb., p. 12. See also Terquem et Piette, 'Mém. de la Soc. Géol. de la France,' 2de série, tome 8, 1865.

⁵ R. Tate, 'Quart. Journ. Geol. Soc.,' vol. xx, No. 78, p. 103.

⁶ Wright, 'Monogr. Ool. Aster., Pal. Soc.,' p. 13; see also Oppel's 'Juraformation.'

SECTION—*APOROSA*.FAMILY—*ASTRÆIDÆ*.*Division*—*LITHOPHYLLACEÆ SIMPLICES*.*Genus*—*MONTLIVALTIA*.

There are seven species of the genus *Montlivaltia* in the Sutton Stone and the deposits at Brocastle, and six of them are new forms, the seventh having already been described by MM. Terquem et Piette.¹ Three of the species belong to the section of the genus which is characterised by forms having their bases and calices of equal width, and three others have a more or less turbinate shape, whilst one species is pedunculated. The discoid *Montlivaltia* appear to be absent, although they are largely represented in the equivalent beds in the east of England and in the north of Ireland.

1. *MONTLIVALTIA WALLIÆ*, *Duncan*. Pl. VIII, figs. 5, 6, 7.

The corallum is cylindro-conical in shape, the base is small, and the calice large, open, and shallow.

The calice is surrounded with a well-marked margin, which is double in some places, and the smallest or rudimentary septa, which are barely visible in the true calice, are distinct on the outer rim.

The septa are very unequal, but narrow and lamellar, and rather plain, but dentate internally. They are not exsert as regards the calicular margin, but curve upwards and then inwards, terminating by a process marked with at least two teeth.

The fourth cycle of septa is incomplete, and the fourth and fifth orders are rudimentary when they exist; so that the septal number is irregular. The rudimentary septa alternate with the larger. There are about thirty well-developed septa of unequal lengths, and between these are the rudimentary septa.

Height of the corallum, $\frac{2}{10}$ ths inch. Breadth of the calice, $\frac{2}{10}$ ths inch.

Locality. Brocastle. In the Collection of Chas. Moore, Esq., F.G.S., Bath.

The wide and shallow calice, the low septal number, and the capacious interseptal spaces characterise this species.

¹ Terquem et Piette, 'Mém. de la Soc. Géol. de la France,' 2de série, tom. 8, 1865.

2. *MONTLIVALTIA MURCHISONIÆ*, *Duncan*. Pl. VIII, figs. 10, 11, 12.

The corallum is short and turbinate: the peduncle is small, and the calice is large, deep, and open.

The epitheca is distinct and swollen out in some places, being slightly constricted in others.

The calice is circular in outline, very deep, and has a sharp margin.

The septa are numerous, very distinct, and very remarkable, both in their arrangement and relation to the costæ.

The largest septa are bluntly dentate and exsert; the rest are faintly dentate, and pass deeply into the fossa, and there are a few rudimentary septa. The rounded costæ are continuous internally with the interseptal spaces, and the septa are continuous with intercostal spaces (fig. 12).

The cyclical arrangement of the septa is confused. There are forty-eight septa, but these do not appear to form four cycles in six systems, but to be arranged in four systems, there being four septa larger than the others.

The height of the corallum is $\frac{7}{8}$ ths inch.

The breadth of the calice is $\frac{1}{8}$ ths inch.

Locality. Brocastle.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

The arrangement of the septa and the depth of the calice distinguish this species very readily. It has its mimetic *Thecosmilia* in *Thecosmilia Brodiei*, Duncan.

3. *MONTLIVALTIA POLYMORPHA*, *Terquem et Piette*.¹ Pl. VII, figs. 14, 15; Pl. VIII, figs. 1—4 and 13—15.

The corallum is simple, very variable in form, and has a thick and folded epitheca reaching to the calice, and is marked with fine and regular costæ. The corallum is rather narrowly pediculate, or adheres by a portion of its base. In shape the corallum may be conical, oblong, or flattened.

The calice is more or less deep, is either round or oval, and its margin is thin. The septa are numerous, have strong teeth on the upper margin, and are smooth laterally. There are five complete cycles, and the sixth is incomplete.

MM. Terquem et Piette do not give the measurements of the Coral, but in their plate the height varies from $\frac{3}{4}$ inch to 2 $\frac{1}{4}$ inches, and the calicinal diameter from $\frac{1}{4}$ inch to 1 $\frac{1}{2}$ inch.

¹ 'Le Lias Inférieur de l'Est de la France,' p. 127, pl. xvi, figs. 17—21.

MM. Terquem et Piette notice that the species is found in great abundance at St. Menge in a bed lower than that containing *Gryphæa incurva* and between the strata containing *Ammonites bisulcatus* (*Bucklandi*) and *A. angulatus*.

The specimens from Brocastle show much of the anatomy of the Coral; and the high septal number and dense wall of the corallites when broken off short are well seen in them.

The taller specimens are often denuded of their epitheca, and the highly developed and inclined endotheca is then well seen. One specimen had a broad base, but the others taper and become rather pedunculate.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

4. MONTLIVALTIA PARASITICA, *Duncan*. Pl. IV, figs. 13, 14.

The corallum is small, very short, has a base as broad as the calice, and is elliptical in outline.

The calice is very shallow. The septa are few in number, are very irregular; and the costæ run a short distance down the sides of the corallum.

The septa are stout and unequal in length, but not very much so in thickness. The shorter septa bend towards and usually unite themselves to a larger septum. There appear to be twelve large septa, and five of these had either one or two smaller septa joined on to them. There would appear to be two complete cycles of equal septa, and that the tertiary cycle is incomplete.

Length of the calice $\frac{1}{4}$ inch. Height of the corallum $\frac{1}{10}$ th inch.

Locality. The Sutton Stone. In the Collection of Charles Moore, Esq., F.G.S., Bath.

The species is founded upon a specimen fixed upon an Astrocænian, and the extreme shortness, the attachment to a very wide base, and the union of the tertiary to the secondary septa, are very distinctive.

5. MONTLIVALTIA SIMPLEX, *Duncan*. Pl. III, figs. 16, 17.

The corallum is short, has a broad base, and an elliptical calice, which is very slightly broader than the base.

The epitheca is strong, does not show any costæ, and it reaches to the calicular margin.

The calice is shallow, and has rather a wide margin.

The septa are very few, very distant, slender, and curved: their arrangement is very

irregular; and although there are six septa which reach nearer the calicular centre than the others, still no cyclical development can be asserted to have existed. There are sixteen septa; three are rudimentary, and there are thirteen of a larger size.

Height of corallum, $\frac{9}{10}$ ths inch.

Long diameter of calice, $\frac{4}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

The paucity of septa and the shape distinguish this remarkable species.

6. *MONTLIVALTIA BREVIS*, *Duncan*. Pl. VIII, figs. 8, 9.

The corallum is short and cylindrical, and has a base as broad as the calice.

The calicular margin is sharp, and the calice is rather irregular in shape: the calicular fossa is shallow, and the septa are few in number.

The septa are unequal, distant, stout, and have a large tooth at the internal end. This dentation is more distinct in the secondary and tertiary cycles than in the primary. There are three cycles of septa, but the third is incomplete. The primary septa are the longest, and reach to the central space, whilst the smallest septa end in a blunt knob, not so near the central space as the termination of the intermediate septa.

Height of the corallum, $\frac{1}{10}$ th inch.

Breadth of the calice, $\frac{1}{4}$ inch.

Locality. Brocastle. In the Collection of Charles Moore, F.G.S., Bath.

The septa are very characteristic of this short and widely based Coral.

7. *MONTLIVALTIA PEDUNCULATA*, *Duncan*. Pl. II, figs. 12, 13; Pl. VIII, fig. 16.

The corallum is large above, cylindro-conical midway, and finely pedunculate at the base.

The epitheca is thin, rather but finely ridged transversely, and permits the costæ which are small to be seen where it is very scanty. The calice is not symmetrical, and the septa are numerous, and apparently constitute five cycles, and part of a sixth. The peduncle is much smaller than the body of the corallum.

Height of corallum $\frac{4}{10}$ ths inch. Width of the calice $\frac{4}{10}$ ths inch.

Locality. In the Sutton Stone, and at Brocastle. In the Collection of Charles Moore, Esq., F.G.S., and in the Museum of Practical Geology, London.

The shape and high septal number distinguish this species.

Division.—LITHOPHYLLACEÆ CÆSPITOSÆ.

Genus.—THECOSMILIA.

The *Thecosmilæ* of the Sutton Stone are principally capitate forms, that is to say, they spring from a peduncle and divide suddenly. The short and fissiparous species, *Thecosmilæ rugosa*, is very common amongst the non-capitate forms, and so is the *Thecosmilæ Michelinii*, Terq. et Piette.

At Brocastle and Cowbridge the larger *Thecosmilæ* are common, but *Thecosmilæ Michelinii* forms large masses at Cowbridge, and studs blocks at Laleston. Although the specimens are very numerous, still the individuals rarely attain that bush-like structure which is noticed in the Continental beds.

At Cowbridge the specimens are mostly found as casts.

1. THECOSMILIA SUTTONENSIS, Duncan. Pl. IV, figs. 7—9.

The corallum has a slender and nearly straight peduncle, which gives off corallites from an enlarged summit.

The peduncle is moderately marked with transverse ridges and constrictions, and does not taper symmetrically from above downwards. The epitheca is thin, and permits very numerous and fine costæ to be seen through it.

The corallites springing from the parent (the peduncle) originate by intercalicinal gemmation; they are separate as regards their walls, and differ in size, being marked with transverse epithecal folds and constrictions. The calices are not quite circular, and their septal arrangement is irregular. The septa are unequal, and one half of them extend nearly to the centre, whilst the smaller pass inwards but for a short distance. The number of septa increases with the growth of the calices. In large calices there are more than four cycles, and in the smaller less than three cycles, or three cycles.

The endotheca is highly developed.

Height of corallum $1\frac{1}{2}$ inch. Diameter of large calice $\frac{1}{16}$ ths inch. Diameter of small calice $\frac{3}{16}$ ths inch.

Locality. The Sutton Stone. In the Collection of Charles Moore, Esq., F.G.S., Bath.

This species has some resemblance to *Thecosmilæ serialis* in its short peduncle and capitate swelling; but the retention of the circular outline by the calices is distinctive. It has some resemblance in its calice to the simple calice of *Thecosmilæ rugosa*, Laube, but there is no fissiparity observed. The origin of the corallites by intercalicinal gemmation is very distinctive, as are also the thin epitheca and the columnar shape of the

peduncle. The habit of the species resembles that of the majority of the stunted *Thecosmilæ* of the period.

2. *THECOSMILIA MIRABILIS*, *Duncan*. Pl. II, figs. 10, 11.

The corallum is short, very finely pedicellate, increasing rapidly in breadth, and terminating by a large upper surface on which are several circular and distinct calices. The trunk of the corallum is smooth, and is slightly marked with rounded transverse swellings, and corresponding constrictions. No costæ can be seen. The corallites are unequal in size, separate immediately, do not increase by fissiparity, and are characterised by circular calices having a very sharp margin. The calices are shallow. The septa are numerous, crowded, and very regular; they are alternately long and short, and all are marked with small lateral swellings and faint linear depressions on the upper edge. The largest calices have four cycles of septa, and nearly a complete fifth cycle, the septa numbering from seventy-six to eighty-four.

Height of the corallum $\frac{7}{10}$ ths inch. Breadth of the upper surface $\frac{6}{10}$ ths inch. Diameter of the largest calice $\frac{3}{10}$ ths inch.

Locality. The Sutton Stone. In the Collection of Rev. H. Winwood, F.G.S., Bath.

3. *THECOSMILIA SERIALIS*, *Duncan*. Pl. IV, figs. 10—12.

The corallum has a narrow, curved, and rather long peduncle, which gives off several corallites from its summit.

The peduncle is strongly marked with lateral ridges and constrictions, and so are the corallites.

The epitheca is stout, and, where worn, permits the costæ to be seen.

The young corallites arising by fissiparity from the parent, which constitutes the peduncle, separate into some which remain circular in transverse outline, and into others which form short serial calices.

The circular calices present four cycles of septa, and the serial have their septa less crowded and larger. The serial calices do not present any evidences of fissiparity.

Height of corallum $1\frac{1}{10}$ inch. Diameter of circular calice $\frac{3}{10}$ th inch. Length of serial calice $\frac{3}{10}$ ths inch. Breadth of serial calice $\frac{1}{10}$ th inch.

Locality. The Sutton Stone. In the Collection of Charles Moore, Esq., F.G.S., Bath.

This species belongs to the stunted *Thecosmilæ* so characteristic of the Triassic and Liassic coralliferous strata; it is readily distinguished by the number of corallites springing from the peduncle, and by its long and serial calices being mixed with rounded ones.

The mineralization of the specimen gives the appearance of a columella in the elongated calice, but there is really no such a structure.

4. *THECOSMILIA RUGOSA*, *Laube*.¹ Pl. II, figs. 1—6.

The corallum springs from a small base, divides soon, and the branches are covered with an exceedingly strong epitheca marked with thick folds.

The calices, one or more in number, are either nearly round, or are irregularly distorted. They are deep, and the septa are stout, straight, and not very unequal. They number from thirty-four to thirty-six.

The diameter of a tolerably regular calice is $\frac{3}{10}$ ths inch, and the length of a distorted calice $\frac{4}{10}$ ths inch. The height of the corallum is about an inch.

Locality. The Sutton Stone. In the Collection of Charles Moore, Esq., F.G.S., Bath.

M. Laube's description of the species from the St. Cassian beds is simple and accurate. His small *Thecosmilia* has a strong epitheca, with constrictions and swellings, and its calices are now and then fissiparous. His plate gives the idea of there being more septa; and this is the only distinction which can be made between the St. Cassian and the British species.

5. *THECOSMILIA BRODIEI*, *Duncan*. Pl. X, figs. 1, 2, 3, 4.

The corallum is rather short; the corallites are cylindrical and large in relation to their height, and they appear to divide near together, so that regular calices are rare.

The epitheca is stout and complete, being marked with slight constrictions.

The calicular margin is sharp, and the calices are deep.

The septa are numerous, and the large primary and secondary septa are equal and very dentate. The tertiary septa are very much smaller than the secondary, are not dentate, but are long; and the septa of the fourth and fifth orders are very small.

Diameter of the calices $\frac{4}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

The extraordinary development of the dentate first and second cycles of septa characterise the species.

¹ Laube, 'Die Fauna der Schichten von St. Cassian,' I Abtheil.

6. *THECOSMILIA MARTINI*, *E. de From.*¹ Pl. X, figs. 6—9.

The corallum is bush-shaped, and is formed by dichotomous cylindrical corallites, which are covered with a strong folded and complete epitheca.

The corallites separate rapidly, and remain free for some distance before fissiparous growth occurs again.

The dissepiments are very developed, and are inclined.

The calices are circular, or slightly oval.

The septa are very thin and distant. There are thirty-two large septa, one half of which reach the centre, and there are forty-eight small, or rudimentary septa.

The calices are about $\frac{3}{8}$ ths inch in diameter.

Localities. Brocastle, Ewenny, Cowbridge. In the Collection of Charles Moore, Esq., F.G.S., Bath.

This species is distinguished by its size, high septal number, and highly developed endotheca.

In the British specimens the septa are stouter, and the calices are often larger than in the French; moreover the larger septa are often raised to the number of forty-eight. The rudimentary septa are not shown in M. Martin's plate.

The localities whence the species has been derived have been the middle and upper beds of the Zone of *Ammonites Moreanus*, at Semur, and Vic de Chassenay Côte d'Or.

It is found in the limestone of Charleville, with *Ammonites bisulcatus*, in the sandstone containing *Ammonites bisulcatus*, at Saul, and in the Hettangian sandstone containing *Ammonites angulatus*. The species had thus a considerable range both in space and time; and it followed the usual habit of widely wandering species, in varying from the true specific type.

7. *THECOSMILIA MICHELINI*, *Terq. et Piette.*² Pl. VII, figs. 10—13; and Pl. X, figs. 10—14.

The corallum is bush-shaped, and is formed by numerous, close, dichotomous, sub-cylindrical, long and slender corallites, which are surrounded with a thick, folded, smooth, complete, and persistent epitheca.

The calices are nearly on the same level, are rounded or oval, and the fossa is not very deep. The septa are forty in number, and are alternately large and small.

The endothecal dissepiments are very close.

¹ Martin, 'Pal. Strat. de l'Infra-Lias,' 1860, pl. viii, figs. 8, 9.

² 'Le Lias Inférieur de l'est de la France,' p. 127, pl. xvii, figs. 7, 8.

The height of the corallum may reach 6 inches.

Diameter of a corallite $\frac{1}{3}$ rd inch.

Localities. Brocastle, Cowbridge, Laleston, the Sutton Stone, and Ewenny. In the Collection of Charles Moore, Esq., F.G.S., Bath.

MM. Terquem et Piette ('Le Lias Inférieur de l'est de la France,' p. 127, Pl. xvii, figs. 7, 8) have described this well-marked species in their usually concise manner. The smaller size of the corallites, the septal number, and the small amount of endotheca, distinguish the species, which is very common in the Glamorganshire beds. The bush shape of the corallum may be imagined from the grouping of the casts of the species in the limestone at Cowbridge; and the dichotomous and slender form of the corallum is common at Laleston and in the Sutton Stone.

The rounded swellings and intermediate constrictions of the plain epitheca are very characteristic.

The French specimens are derived from the beds at Aiglemont, in the zone of *Ammonites angulatus*.

8. *THECOSMILIA IRREGULARIS*, *Duncan*. Pl. III, figs. 1—6; and Pl. X, fig. 5.

The corallum is small, short, and has a broad base. It consists of a short and rather cylindrical peduncle with a broad base, a very strongly marked and ridged epitheca, and of an upper part whence the calices spring by fissiparity.

The calicular surface is considerably broader than the peduncle, and overhangs.

The calices are small, shallow, irregular in shape, and have a distinct margin.

The septa are few in number, large, unequal, and very irregular in their arrangement. They have large rounded teeth upon their upper margins, and the larger septa occasionally unite by their inner margins, which are toothed.

There are about twenty septa, and several others which are rudimentary.

There are no costæ.

Height of corallum $\frac{4}{10}$ ths inch. Diameter of calices $\frac{3}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

THECOSMILIA IRREGULARIS, *Duncan*. (A variety.) Pl. III, figs. 14, 15.

The calices are deeper, the septa longer and more slender, and the dentations sharper and more distinct than in the type.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

9. *THECOSMILIA TERQUEMI*, *Duncan*. Pl. III, figs. 7—12.

The corallum has a fine pedicle, which increases in breadth very rapidly, and produces a large upper surface, upon which are the calices, or one corallite may spring from the edge of the upper surface, and give rise to others in the same manner. (Plate X, fig. 4.)

The epitheca is strong, folded, and constricted; where worn, the costæ and exothecal dissepiments appear.

The calices are irregular in shape, size, and distance.

The septa are unequal in size and are bluntly dentate, their arrangement is irregular, and a quaternary disposition of the laminæ is very evident, and they may number sixteen, twenty, or thirty-two. The larger septa do not indicate an hexamerous arrangement. All are thick, distant, and pointed internally.

Height of the corallum $\frac{4}{10}$ ths inch. Diameter of the calices $\frac{2}{20}$ ths— $\frac{4}{20}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

10. *THECOSMILIA AFFINIS*, *Duncan*. Pl. III, figs. 18—20.

The corallum is short, and the corallites separate soon after leaving a short, conical peduncle.

The calices are deep and open.

The septa are irregular, unequal, distant, often curved, dentate at their inner margin, and about sixteen in number.

The epitheca is moderately strong.

The height of the corallum is $\frac{6}{10}$ ths inch. The diameter of the calices is $\frac{4}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

11. *THECOSMILIA DENTATA*, *Duncan*. Pl. III, figs. 21—23.

The corallum has a broad base, and the corallites separate soon, and diverge; they are subcylindrical, and their epitheca is smooth.

The calices have a very distinct margin; they are slightly deformed, not very deep, and contain numerous septa.

The septa are unequal; alternately large and small, irregular, and present distinct and numerous blunt dentations. The smallest septa are simple dentations, and the different sizes of the septa and dentations are very remarkable.

There is no exact arrangement of the septa in cycles, and their number varies from thirty to thirty-two and thirty-six.

Height of corallum $\frac{7}{10}$ ths inch ; breadth of calice $\frac{4}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

12. *THECOSMILIA PLANA*, *Duncan*. Plate III, figs. 24, 25.

The corallum is short, the calices separate rapidly, and soon attain a considerable size.

The epitheca is strong, and constricted here and there.

The calices are large, shallow, oval, and are deeper at the centre than elsewhere ; their margin is indistinct, and the septa are rounded, faintly dentate, distant, and very irregular. There are about thirty septa.

Height of corallum $\frac{4}{10}$ ths inch ; breadth of calice $\frac{6}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

These species of the genus *Thecosmilia* may be arranged for the purposes of diagnosis as—

Long and more or less bush-shaped	{ <i>Th. Martini</i> . <i>Th. Michelini</i> .
Pedunculate and capitate	{ <i>Th. Suttonensis</i> . <i>Th. mirabilis</i> . <i>Th. Terquemi</i> . <i>Th. serialis</i> .
Short and stunted	{ <i>Th. irregularis</i> . <i>Th. rugosa</i> . <i>Th. plana</i> . <i>Th. Brodiei</i> . <i>Th. dentata</i> . <i>Th. affinis</i> .

Taken as a series, the species are very characteristic of the Coral-fauna of the period.

Genus—RHABDOPHYLLIA.

1. *RHABDOPHYLLIA RECONDITA*, *Laube*.¹ Plate II, figs. 7—9.

The corallum is pedunculated, has very fine costal markings, which are flat, and a delicate epitheca.

The corallites separate rapidly at the extremity of the peduncle.

The calice (section of) is almost circular, and is crowded with rather stout septa.

The septa are unequal, longer at the calicular margin than elsewhere, and either reach the columella or enlarge at their free extremity at different distances from it.

¹ Laube, 'Die Fauna der Schichten von St. Cassian,' 1 Abtheil.

There are four cycles of septa in six systems. The primary reach the columella. The tertiary, which are longer than those of the higher orders, join the secondary septa.

The columella is well defined, and is circular in its transverse outline.

The diameter of the corallite is about $\frac{1}{4}$ inch.

The specimens are usually covered with parasitic corals or sponges.

Locality. The Sutton Stone. The St. Cassian beds. In the Museum of Practical Geology, London.

Laube's¹ description of this species is very faithful, and it is readily recognised by the curious septal arrangement. The specimens are rare in the Sutton Stone, and the sections showing the septa require very careful examination before they can be understood.

FAMILY—ASTRÆACEÆ.

Genus—ASTROCENIA.

1. *ASTROCENIA GIBBOSA*, *Duncan*. Pl. V, figs. 2, 3, 4, 12; Pl. IV, fig. 3; Pl. VI, figs. 1, 2, 3, 4.

The corallum is large, and covered with rounded eminences of various sizes.

The calices are large, polygonal, close, irregularly placed, irregular in size, and shallow.

The septa are usually twenty in number, are joined to small narrow club-shaped straight costæ, are very unequal in size, and usually one half of them reach to the columella. The smaller and shorter septa unite in many instances to the larger septum between them, but not very close to the columella. The septa are finely dentate laterally, and there is a trace in some of the longest of a swelling close to the columella. Their development is very irregular.

The columella is moderately prominent and large.

The cœnenchyma is not strongly developed, but in sections the presence of ornamentation in the form of round processes is observable. The endothea is occasionally noticed in the calicular fossa, and extends from septum to septum.

Three large calices, with their cœnenchyma, occupy the length of nearly $\frac{3}{10}$ th inch.

Locality. The Sutton Stone, and Brocastle.

In the Museum of Practical Geology, London; and in the Collections of Charles Moore, Esq., F.G.S., and Rev. W. Winwood, F.G.S., Bath.

¹ Laube, *op. cit.*

2. *ASTROCENIA PLANA*, *Duncan*. Pl. V, fig. 1.

The corallum is large, flat, and short.

The calices are small, very regular in their linear arrangement, polygonal, and nearly equal: they are rather deep and rather distant.

The septa appear to be from eight to ten in number, and reach the columella.

The costæ are very indistinct.

The columella is large.

The cœnenchyma is well developed, and becomes divided into rounded eminences between the calices; and where four of these are together, the intervening cœnenchyma is decidedly peaked.

Three of the largest calices, with the intervening cœnenchyma, cover a length of $\frac{3}{10}$ ths inch.

Locality. The Sutton Stone. In the Museum of Practical Geology, London.

3. *ASTROCENIA INSIGNIS*, *Duncan*. Plate IX, figs. 1 and 2.

The corallum is large; it is flat on the upper surface, and is short.

The calices are somewhat regular in their linear arrangement; they are unequal, and are irregular as regards their outline and distance. They are shallow, and are large in comparison with those of most of the species of the genus.

The septa are large, and nearly equal in size at the calicular margin, but all do not reach the columella. Generally five primary septa extend to the columella, and there are three which only reach a little way into the calicular fossæ between the longer primary. The central of these smaller septa is often longer than those on each side of it. The septal number is irregular, but twenty is the usual number. In some calices the shorter septa are decidedly smaller than the others.

The costæ are large, broad, straight, nearly equal, club-shaped, close, and are oblique in some, but flat in other calices. They extend over the cœnenchyma when it exists, do not coalesce with those of other calices, and are often separated by a ridge. Neither septa nor costæ appear to be spined or dentate, but a very slight unevenness of the margin may be noticed in well-preserved specimens.

The columella is small, sharp, and prominent.

The size of the calices varies, and in large specimens, where there is some cœnenchyma, three calices and their cœnenchyma occupy rather more than $\frac{3}{10}$ ths inch. The smallest calices, with a small quantity of cœnenchyma, do not occupy one half of that space.

Locality.—Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

4. *ASTROCÆNIA REPTANS*, *Duncan*. Plate IV, figs. 4, 5, 6, 15.

The corallum is short, convex, and very irregular; it is moderately large for an Astrocænian, and is covered with numerous and closely packed calices.

The calices are polygonal and shallow, and are separated by very distinct, plain, cœnenchyma, which is obtusely ridged, and prominent here and there.

The septa are twenty in number; ten reaching the columella, and ten joining five of the longer, in pairs.

The septal arrangement is very marked.

The columella is small and the costæ are rudimentary.

The length of three calices, with the cœnenchyma, is about $\frac{3}{30}$ ths inch.

Locality. The Sutton Stone, Brocastle, and at Eweny. In the Collection of Charles Moore, Esq., F.G.S., Bath.

5. *ASTROCÆNIA PARASITICA*, *Duncan*. Plate V, figs. 5, 6.

The corallum encrusts other *Madreporaria*, such as dendroid *Astræaceæ* or "remanic" Lithostrotions; it is small and short, and possesses much cœnenchyma.

The calices are very small, distant, and shallow.

The septa appear to be ten in number.

The columella is well marked.

The cœnenchyma is plain.

The diameter of the calices is about $\frac{1}{30}$ th inch.

Locality. The Sutton Stone. In the Museum of Practical Geology, London.

6. *ASTROCÆNIA PEDUNCULATA*, *Duncan*. Plate V, figs. 7, 8, 9.

The corallum is small, pedunculate, and fungiform; it has an epitheca and much cœnenchyma.

The peduncle is short, small, and rounded, and joins the expanded discoid epithecate base of the true corallum near its centre.

The discoid base has an epitheca, and its edges are slightly rounded.

The convex upper part of the corallum is covered with unequal, shallow, and distant calices.

The calices are irregular in size, and are small.

The septa are small, alternately long and short, and are granulated laterally. There are twenty of them, and the smallest are rudimentary.

The cœnenchyma is abundant, and is elevated between some calices and flat between others.

Height of the corallum $\frac{4}{10}$ ths inch.

Locality.—Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

7. *ASTROCÆNIA COSTATA*, *Duncan*. Pl. IX, figs. 15, 16, 17.

The corallum is small, irregular in shape, and rounded above.

The calices are numerous, and rather deep; they are either very close together, or they are separated by more or less cœnenchyma, whose upper surface is marked by wavy costæ.

The septa are usually twenty in number, and their costal ends are nearly equal.

The costæ are either very small, small and curved, or large and more or less curved as they approach the costæ of neighbouring corallites.

The columella is small.

The space occupied by three large calices, separated by much cœnenchyma, is $\frac{9}{10}$ ths inch.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

8. *ASTROCÆNIA FAVOIDEA*, *Duncan*. Pl. IX, figs. 12, 13, 14.

ASTRÆA FAVOIDES? *Quenstedt*, *Der Jura*, 1858.

The corallum is more or less globose, and the calices are very small, very deep, and are separated by sharp ridges. The cœnenchyma is rudimentary.

The septa are twenty in number, the smaller being very rudimentary.

The costæ are rudimentary.

The columella is small, and is situated at the base of the very deep calice.

Localities. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath. Also in the Arietien-Kalk of Germany.

9. *ASTROCÆNIA SUPERBA*, *Duncan*. Pl. IX, figs. 3, 4, 5.

The corallum is small, and irregular in shape.

The calices are shallow, wide apart, and usually circular in outline.

The septa are usually twenty in number, are small near the columella, and thicker at the costal end. About one half of them reach the columella. They are dentate.

The costæ are highly developed, and cover the cœnenchyma, which is also spiny between the costal ends. Nearly all the costæ are equal; they are straight in some places and wavy in others, but all are strongly dentate and well marked.

The columella is small.

Three calices occupy about $\frac{1}{4}$ inch in length.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

10. *ASTROCCENIA DENDROIDEA*, *Duncan*. Pl. IX, figs. 9, 10.

The corallum is in small branches, with blunt extremities.

The cœnenchyma is highly developed and plain.

The calices are wide apart in some places, but close in others; they are shallow, small, and more or less circular.

The septa are very irregular in their number, and their costal ends are club-shaped and rounded.

The columella is small.

The branches rarely exceed $\frac{1}{2}$ inch in length.

Locality. Brocastle, and at Ewenny. In the Collection of Charles Moore, Esq., F.G.S., Bath.

11. *ASTROCCENIA MINUTA*, *Duncan*. Pl. IX, figs. 18, 19, 20.

The corallum is large, flat, and thin. It is more or less encrusting in its habit.

The calices are very small, rather deep and close: they are more or less circular in outline, and are separated by a small quantity of cœnenchyma.

The septa are usually twenty in number, and many of them have a paliform tooth close to the columella. The costæ are small.

The columella is small.

Locality. Brocastle. In the Collection of Charles Moore, Esq., F.G.S., Bath.

12. *ASTROCCENIA SINEMURIENSIS*, *D'Orb.*, sp.¹

The corallum is in the shape of a rounded mass, which is formed of superimposed layers. The calices are small, and tolerably regularly polygonal. The columella is stout, and projects. The septa are rather thick, unequal, and slightly close. There are twenty

¹ Martin, op. cit., pl. vii, figs. 26, 27.

in each calice, ten large and ten small. The internal ends of the large septa are rounded and swollen out.

Diameter of the calices $1\frac{1}{2}$ inch.

M. D'Orbigny considered the swollen ends of the principal septa to be pali, and placed the species in the genus *Stephanocænia*, but M. de Fromentel determined the correct position of the form to be amongst the "decemeral" *Astrocæniæ*.¹

The species does not appear to have been formed from very perfect specimens, and in M. J. Martin's admirable plate the septa are all equal in length and thickness, and the calices are close together. It is impossible to determine from either the description or the plate whether the calices are deep, whether there is any ornamentation, or whether the cœnenchyma is marked in any way. There are many species of *Astrocænia* which are massive, and their formation from superimposed layers is the result more of a process of mineralization than of growth. The form is readily recognisable in its strata, because it is rare and as yet the only species discovered; but placed in comparison with others from distant localities it is hardly to be distinguished, on account of its defective specific distinctive peculiarities. The *Astrocæniæ* of the Sutton Stone, and from Brocastle, show the smaller septa joining the larger more or less, but this does not appear to be the case in *A. Sinemuriensis*. The enlarged state of the septal ends is common to several *Astrocæniæ*. It is very probable that with more complete specimens, the occasional union of the septa will be observed in *A. Sinemuriensis*, for in some specimens of most of the species this non-union is seen in certain calices.

Specimens of some *Astrocæniæ* in the Sutton Stone and Brocastle beds put on all the appearances of this species when worn. It is therefore introduced here; but not figured.²

The genus *Astrocænia* was formerly included in the *Eusmilina aggregata*, but Reuss³ pointed out the fact that the upper margins of the septa of the species falling under his observation were dentate and not smooth.

M. de Fromentel⁴ discovered in the Neocomian formation some species which had dentate septa; and after acknowledging Reuss's discovery, he placed the genus amongst the XXVth family of his classification, the "*Astrœens*." This family corresponds in part to the *Astræaceæ* of Milne-Edwards and J. Haime, and the genus may be considered to form a part of the *Astræaceæ*.

In the Introduction to the British Fossil Corals,⁵ *Astrocænia*, being placed amongst the *Eusmilina*, follows the genus *Stylocænia*, and was evidently considered to be closely allied to it. The following is the generic diagnosis by MM. Milne-Edwards and J. Haime:

¹ Pal. Strat. de Infra-lias, p. 94. J. Martin, 1860.

² See "Remarks on *Astrocænia Sinemuriensis* and *Astrocænia Oppeli*," Laube, in my essay on the "Madreporaria of the Infra-Lias of South Wales," Quart. Journ. Geol. Soc., Feb. 1867, p. 25 (note).

³ Reuss. 'Beiträge, zur Charakteristik der Kriedeschichten.'

⁴ E. de Fromentel, 'Introd. à l'Étude des Polyp. Foss.'

⁵ 'Introd. to Brit. Foss. Corals: Palæontogr. Soc.'

"Corallum very dense, and not bearing columnar processes, as in the preceding genus. Calices polygonal, columella styliform, not projecting much. No pali. Septa thick, apparently eight or ten systems, two or four of the secondary septa being as much developed as the six primary ones. Walls thick and united as in *Stylocænia*."

M. de Fromentel separated the genera *Astrocænia* and *Stylocænia*, and retained the latter amongst the *Eusmilinæ aggregatæ*. There was no reference made, therefore, in his generic diagnosis of *Astrocænia* to the genus *Stylocænia*. M. de Fromentel's description of the generic peculiarities of *Astrocænia* are as follows: "Corallum massive, composed of corallites united by their walls, which are prismatic in shape; the calices are polygonal; the columella is styliform, and more or less projecting; the septa are tolerably thick, are few in number, and are dentate, especially near the columella; there are no pali."

Whilst investigating the Madreporaria of the Maltese rocks in 1865, I found that the septa of the common species *Stylocænia lobato-rotundata*, Mich. sp., were dentate.¹ The species occurs also in the Chert of Antigua, and presents there the usual plain septa considered to mark the family of the genus. If fossilization can remove the dentations of the septa of one *Stylocænian*, it can do so in others, and it may be safely asserted that all the *Stylocænians* had dentate septa.

This dentate condition of the septa brings the genera *Astrocænia* and *Stylocænia* together again, although it removes them from the *Eusmilinæ* into the *Astræaceæ*.

MM. Milne-Edwards and J. Haime's generic description can thus stand, and its concluding sentence respecting the thick walls of the genus which was omitted by M. de Fromentel is very important.

In some species, as in *A. pulchella*, Ed. & H., the calices are so wide apart in some specimens, and in certain spots in all the specimens, that there is evidently here and there a cœnenchyma between the walls of the corallites. The surface of the cœnenchyma, which appears to arise from an hypertrophied condition of the adjacent corallite walls, is usually ornamented either with prolongations of the costæ, or with small papillose granules. This is observed in other species, and it is noticed that the amount of cœnenchyma varies according to the shape of the corallum, and the rapidity of the multiplication of the corallites. The presence of scattered granules, or of small papillæ on the cœnenchymal surface, and between the external terminations of the costæ, is observed in some specimens of a species, and not in others; but the costæ, although they may extend far over the inter-calicular spaces (or, in other words, over the surface of the cœnenchyma), never unite, and run into those of adjoining corallites. There are modifications in the length and straightness of the costæ, and where there is no cœnenchyma, and the walls of the corallites are thin, they may be so reduced in size as to appear to be simple terminations of septa.

In many species the cœnenchyma, when non-costulated, and not ornamented with granules, becomes slightly ridged, and foreshadows the condition which peculiarises the genus *Stylocænia*.

¹ 'Ann. Mag. Nat. Hist.,' April, 1865.

The reproduction by gemmation cannot occur from the walls of the corallites, except at the edge of the corallum. The close contact of the walls, and the existence of dense cœnenchyma, prevent any budding from the wall; but where the outside corallites are partly free, there gemmation may occur outside and below the calicular margin.

Fissiparity does not occur, but the young buds arise either from the top of the calicular edge or margin, or just within the calice. When there is some distance between the calices on account of the thickened walls or cœnenchyma, buds may arise on the cœnenchymal or inter-calicular surface.

Many of the species have an epitheca, some are pedunculated, and others are massive, encrusting, or dendroid.

The septa vary greatly in their numbers and cyclical arrangement, and very often they have a large paliform tooth close to the columella. There are no pali.

A styloid columella projecting more or less, is an essential generic requisite. The endothea is scanty, but it always exists.

The calices are small, and vary in depth; but, as a rule, they are arranged with great symmetry, and are polygonal in outline. Transverse sections show the complete consolidation of the walls, and the space between the costal ends, in these sections, is often marked with granules.

The species without any cœnenchyma, and whose walls are thin, are distant in their alliance to *Stylocœnia*, and had they no columella, they would be considered to belong to the genus *Isastrœa*. The genus *Cyathocœnia* (Duncan) comprehends *Astrocœnia* without columellæ.

The fossil condition of the specimens must be considered during the specific determination of *Astrocœniæ*. Usually, the columella is represented by a flat, central, and more or less circular mass with the ends of thick septa adherent to it. In these instances a calcareous deposition has occurred around the columella and between the septal ends, the columella having been broken off. It happens, however, that the columella may be broken off without the deposition having taken place, and either the structure retains its normal size at the point of fracture, or is absent altogether.

On examining doubtful specimens which have lost their columellæ, much attention should be paid to longitudinal sections produced by weathering, fracture, or by artificial means. A small projection at the base of the calice is more readily determined to exist in longitudinal views than in those which simply show the open calice.

There are eleven species of the genus *Astrocœnia* special to the Welsh Lias, and one species found with these has been described by D'Orbigny as *Stephanocœnia Sinemuriensis*. M. D'Orbigny obtained his specimens from the Lower Liassic deposits of France. M. de Fromentel and MM. Terquem and Piette have found the species in several localities, and the first-named palæontologist has determined it to belong to the genus *Astrocœnia*.

The Liassic *Astrocœniæ* occur as large and massive, small and dendroid, or as irregu-

lar and sometimes as encrusting forms. All are very irregular in their septal arrangement, and none of them present definite and clear cyclical sequences.

Some of the species have the cœnenchyma between the calices irregularly ridged, so as to present the first traces of that cœnenchymal development which characterises the genus *Stylocœnia*. The columella is very distinct in all the species, and the junction of the largest septa to it is marked in some forms by a paliiform swelling, but there are no pali. In many species the smaller septa unite more or less to the larger, and in others the dentate condition of the septal edge is very marked. The costæ are either rudimentary or well developed in different species; they may be straight, spined, and wavy.

The size of the corallum, its shape and its habit, with the size of the calices, and the character of the costæ and of the cœnenchyma, appear to separate certain forms from others and enable eleven new species to be classified with the *Astrocœnia*.

The following scheme of the structural peculiarities of the new *Astrocœnia* will show how readily their specific distinctions may be recognized :

ASTROCœNIA.

Corallum	large	gibbous and tall	<i>Astrocœnia gibbosa.</i>
		flat and short	<i>— plana.</i>
		short, and irregular in outline	<i>— insignis.</i>
	small	encrusting	<i>— reptans.</i>
		pedunculate, with an epitheca	<i>— parasitica.</i>
		dendroid	<i>— pedunculata.</i>
		flat and narrow	<i>— dendroidea.</i>
		globose	<i>— superba.</i>
		irregular	<i>— favoidea.</i>
	flat and semi-encrusting	<i>— costata.</i>	
		<i>— minuta.</i>	

Corallum having the cœnenchyma	scanty		<i>Astrocœnia favoidea.</i>
			<i>— minuta.</i>
			<i>— parasitica.</i>
	abundant		<i>— dendroidea.</i>
			<i>— superba.</i>
			<i>— pedunculata.</i>
			<i>— insignis.</i>
			<i>— reptans.</i>
	moderately developed		<i>— costata.</i>
		<i>— gibbosa.</i>	
		<i>— plana.</i>	

The surface of the cœnenchyma	ornamented .	{ costæ well developed	{ and straight spined wavy	{	<i>Astrocœnia insignis.</i>
						— <i>superba.</i>
						— <i>costata.</i>
	ridged	{	{	{	— <i>gibbosa.</i>
						— <i>gibbosa.</i>
						— <i>plana.</i>
						— <i>minuta.</i>
						— <i>reptans.</i>
						— <i>dendroidea.</i>
	plain	{	{	{	— <i>parasitica.</i>
						— <i>pedunculata.</i>
	rudimentary					— <i>favoidea.</i>

Genus nov.—CYATHOCÆNIA.

This genus has been determined for species which, had they columellæ, would belong to the genus *Astrocœnia*.

The walls of the corallites of the species are joined, and there is more or less cœnenchyma. The costæ are not confluent, and the septa are finely dentate. There are no pali, nor is there a columella. There is no fissiparity, and the gemmation is either from the intercalicular surface, or from the calicular margins.

There is always some cœnenchyma present, and this distinguishes the new genus from *Isastræa*, the only genus with which it can be confounded.

The following is the generic formula :

Cyathocœnia.—The corallum is compound. The corallites are united by their walls and by more or less cœnenchyma; they are more or less polygonal, but are often cylindrical. The calices are small, the costæ are not confluent, and the septa are finely dentate. There is no columella. There are no structures on the cœnenchyma between the calices except granules and costæ. The gemmation is superior and marginal.

1. CYATHOCÆNIA DENDROIDEA, *Duncan*. Plate IX, figs. 6, 7, 8, 9.

The corallum is large and tall, forming fasciculate masses. The corallites are more or less crowded on the surface of stems, which branch rarely, and which are close and more or less parallel. The transverse outline of the stems is irregular, from variability in their thickness, and also from the presence of superficial calices. The stems consist of calices separated by cœnenchyma whose amount varies.

The calices are distant when there is much cœnenchyma, but occasionally they are close, and their margin then becomes round; they are small, are irregularly placed, and are rather deep.

The septa are dentate, distinct, distant, unequal, stout, not exsert, and pass obliquely downwards and inwards, so that they do not encroach much upon the calicular fossa. There are eighteen in some and twenty-four in the largest calices. Three cycles appear to be the normal number. There is no columella.

The costæ either reach on to the surface of the cœnenchyma or end abruptly at the calicular margins, and they never become continuous with those of other calices.

The stems are several inches in height, and are from $\frac{3}{30}$ ths to $\frac{4}{30}$ ths of an inch in diameter.

The calices rarely exceed $\frac{1}{12}$ th of an inch in diameter.

Locality. Brocastle.

In the Collection of Charles Moore, Esq., F.G.S.

The peculiar mineralization of the specimen prevents the structure of the central parts of the stems being distinguished.

There is a dendroid Astrocoenian in the Brocastle beds which has some resemblance to this species, but the well-developed columella of the first distinguishes it at once.

MM. Terquem and Piette have described a species *Microsolena Fromenteli*,¹ whose bush-like form and parallel constricted and irregular stems resemble *Cyathocœnia dendroidea*, but the calices have a columella, and the costæ are continuous; nevertheless, the "habit" of both species is very similar.

2. CYATHOCœNIA INCRUSTANS, *Duncan*. Pl. IV, figs. 1, 2.

The corallum is very thin and encrusts portions of the shells of Bivalve Mollusca.

The calices are unequal, circular or subpolygonal, rather close and very shallow. The septa are few in number, are very small, and are marked with distinct and almost moniliform processes. They are thickest at the margin of the calices. The larger septa usually alternate with smaller, but, as a rule, the largest are the most numerous.

The septa cannot be recognized as following a cyclical arrangement, and they vary in number from fifteen to twenty.

There is no columella. The cœnenchyma is scanty and is marked with large granules, which are the representatives of costæ. The gemmation occurs between the calices.

Diameter of calices $\frac{1}{30}$ th to $\frac{1}{10}$ th of an inch.

Locality. The Sutton Stone, encrusting an *Ostrea*.

In the Collection of Charles Moore, Esq., F.G.S.

The papillate septa and encrusting habit distinguish the species from *C. dendroidea*, and *C. costata*.

¹ Op. cit., pl. xvii, figs. 11, 12.

3. *CYATHOCÆNIA COSTATA*, *Duncan*. Pl. V, figs. 10, 11.

The corallum is flat, and presents slightly rounded eminences; it is short, and has an irregular base where it is attached to foreign bodies.

The calices are numerous, nearly equal, and distant. The margins of the calices are flat, and are continuous externally with the cœnenchyma, whose upper surface is covered by the costæ.

The calicular fossæ are deep.

The septa are small, unequal as regards length, but rather equal in their thickness; they vary in number from twenty to twenty-four.

There is no columella.

The costæ are large, slightly rounded, not continuous, and occasionally slightly wavy.

Three calices occupy a length of $\frac{2}{10}$ ths inch.

Locality. Brocastle.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

Genus—*ELYASTRÆA*.¹1. *ELYASTRÆA FISCHERI*, *Laube*.² Pl. VI, figs. 5—9.

The corallum is massive; the corallites are close and united above and near the calices, but separate and more or less covered with epitheca below.

The corallites are unequal in size, tall, and more or less cylindrical below and polygonal above.

The calices are very variable in shape and size, and the margin is broad and distinct.

The septa are numerous, often wavy, unequal in length, and near to the centre of the calice a new set appears to come in, in some calices. There are no pali.

The number of septa depends upon the size of the calice, and it may vary from forty to sixty.

The septal laminæ are thin, and faint traces of costæ may be seen where the walls are not fused together.

The gemmation is extra-calicular, but the bud probably springs from the centre of a corallite, and works its way outwards.

The columella is rudimentary.

Diameter of calices, $\frac{2}{10}$ ths to $\frac{4}{10}$ ths inch.

Locality. The Sutton Stone. The St. Cassian beds.

In the Museum of Practical Geology, London.

¹ Laube, op. cit., and 'Intro. Brit. Foss. Corals,' 2nd series, part i.

² Laube, op. cit.

2. *ELYSASTRÆA MOOREI*, *Duncan*. Pl. VI, figs. 10—15.

The corallum is massive, and the upper surface is very irregular.

The corallites are joined by their walls in many places, but are free in others, both superiorly and lower down in the corallum.

The corallites vary greatly in size, and the smallest are usually joined by their walls, and are more or less angular in outline. The largest corallites are circular in outline.

The calices are irregular in their depth, and are either circular or polygonal. They are close, even when not adherent.

The septa are alternately large and small, are faintly dentate, and are very variable in number. There are forty-eight septa in the largest calices.

The costæ are continuous with the septa in the separate corallites, but do not exist when the walls are united.

The columella is deficient.

The endotheca is very abundant.

The diameter of the calices is from $\frac{2}{10}$ ths— $\frac{4}{10}$ ths inch.

Locality. The Sutton Stone, and at Brocastle.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

The genus *Elysastræa* is very remarkable; it has affinities with *Isastræa* and with the very close bush-shaped *Thecosmilæ*. The bush-shaped *Thecosmilæ* are noticed to become united by their walls in some specimens, and the walls of *Septastræa* and *Prioastræa* are occasionally not united inferiorly.

The species *Elysastræa Moorei* has its corallites more distinctly separate than the St. Cassian form, which is, however, clearly represented in the Sutton Stone.

The appearance of septa near the centre of the calice is very characteristic of the genus.

Genus—*ISASTRÆA*.

1. *ISASTRÆA SINEMURIENSIS*, *E. de Fromentel*.¹ Pl. VII, figs. 1—9.

The calices are polygonal, and tolerably deep.

The septa are very numerous, spined, close, and unite occasionally by their inner

¹ Martin, 'Pal. Strat. de l'Infra-Lias du dép. de la Côte d'Or,' 1860, pl. vii, figs. 16, 17.

border. There are seventy-eight septa in the largest calices, and they are unequal. The calices are from $\frac{3}{16}$ ths— $\frac{4}{16}$ ths inch in diameter.

To this specific determination of M. de Fromentel the following may be added, as better specimens have been derived from the Brocastle bed than elsewhere.

The corallum is massive, and irregular in shape, but often assumes a subglobular form. When this is the case there is an epitheca, which is strongly folded, but which is lost as the calices are developed.

The size of the calices is very irregular, and marginal gemmation is very common.

The septa are crowded and distinct, and in the largest calices there are many of the fifth cycle, but there is great irregularity in the septal number. The septa are often not quite straight, and present swellings at several points.

Locality. Brocastle. Menetreux, near Samur.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

2. ISASTRÆA GLOBOSA, *Duncan*. Pl. VIII, figs. 17, 18.

The corallum is nearly spherical in shape; it has a cylindrical but short peduncle, covered with epitheca, and a rounded upper surface marked with very numerous and closely placed small calices.

The calices are shallow, faintly polygonal, and crowded with septa. The septa are unequal, not very thin, and have now and then an enlargement at the inner end. The smaller septa frequently unite to the larger. All are very distinct. A cyclical arrangement of the septa cannot be distinguished, and the septal number varies from twenty, twenty-four, to thirty-six.

There is no columella.

The diameter of the calices is about $\frac{1}{16}$ th inch.

Locality. Brocastle.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

The largest specimens of this fossil are usually much worn, and some care must be taken in examining the perfect calices, for their mineralization often suggests a columella.

Genus—LATIMÆANDRA.LATIMÆANDRA DENTICULATA, *Duncan*.

One or two calices of a *Latimæandra* occur in several of the hand-specimens in the Collection of Charles Moore, Esq., F.G.S. The calices are long and are straight; they are separated by sharp walls, and the larger septa have a high paliform tooth close to their inner end. This structure of the septa distinguishes the species; but as no very satisfactory views can be obtained of a series of calices in the specimens, it has not been thought worth while to have the incomplete structures drawn.

Locality. Brocastle.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

Division—FAVIACEÆ.*Genus*—SEPTASTRÆA.SEPTASTRÆA EXCAVATA, *E. de Fromentel*.¹ Pl. I, figs. 6, 7.

The corallum is rather tall and rounded.

The corallites are intimately united by their walls, which, although very thin, have a slight line of separation between them.

The calices are polygonal, irregular, and deep.

The septa are thin, distant, and strongly dentate, especially near the centre.

Fissiparity occurs, and the longest calices may have three calicinal centres.

In simple calices there are from thirty-six to forty-two septa, which are unequal. The hexamerous type is very distinct.

The diameter of simple calices is from $\frac{2}{10}$ ths to $\frac{3}{10}$ ths inch.

In the specimens from Brocastle the abrupt rise of the septa near the calicular margin is very well seen. The calices are very irregular, and the longitudinal sections show constrictions and irregular swellings, which are very characteristic. Most of the calices have forty-eight septa or more, especially those about to divide.

Locality. Brocastle; and Pont d'Aisy, Côte d'Or.

In the Collection of Charles Moore, Esq., F.G.S., Bath.

¹ Martin, op. cit., pl. viii, figs. 1—5.

The remarkable *Thecosmilia rugosa*, *Rhabdophyllia recondita*, and *Elysastræa Fischeri*, from the lower part of the Sutton Stone, have been described and drawn by Laube from the St. Cassian beds of the Trias. The fauna with which they are associated in the Trias has not been described; but the presence of the species in the Angulatus-Zone of the Lower Lias or the Infra-Lias is very interesting.

The species described by Terquem and Piette, E. de Fromentel, and D'Orbigny, viz. —

- Isastræa Sinemuriensis*, E. de From.,
Septastræa excavata, E. de From.,
Montlivaltia polymorpha, Terquem et Piette,
Astrocænia Sinemuriensis, D'Orb., sp.,
Thecosmilia Martini, E. de From.,
 „ *Michelini*, Terquem et Piette,

are associated in the Continental Liassic strata with many of the species of Mollusca which are noticed in the Sutton Stone and in the deposits at Brocastle in Glamorganshire.

In the *Lumachello* of the upper series of the Infra-Lias of Normandy¹ (the Calcaire de Valogne) *Septastræa excavata* is found to be associated with the following species, found also with it in the Glamorganshire Lias, which rests on Carboniferous Limestone:

- Cerithium acuticostatum*, Terquem.
Turritella Dunkeri, Terquem.
 „ *Zenkeni*, Dunker, sp.
Phasianella Morencyana, Piette.
Ostrea anomala, Terquem.
Cardinia regularis, Terquem.

At Vic de Chassenay² *Thecosmilia Martini*, E. de From., and *Astrocænia Sinemuriensis*, D'Orb., sp., are associated with—

- Ammonites Moreanus*, D'Orb.
Littorina clathrata, Desh.
Cerithium Semele, D'Orb.
 „ *gratum*, Terquem.
 „ *acuticostatum*, Terquem.

The middle bed of the Grès calcaireux described by Terquem ('Pal. de Hettange,'

¹ Deslongchamps, 'Mém. Soc. Linnéenne de Normandie,' vol. xiv, 1864.

² Martin, 'Pal. Strat. de l'Infra-Lias,' &c., 1860.

1855), contains *Isastræa Sinemuriensis* and the following species, in addition to the Mollusca just mentioned from the Côte d'Or and the Calcaire de Valogne :

Neritopsis exigua, Terquem.
Gervillia acuminata, Terquem.
Lima tuberculata, Terquem.
Plicatula intusstriata, Emm.
Ostrea irregularis, Münst.

These species, common in the French beds which are included in the Zone of *Ammonites angulatus*, and which form part of the Lower Lias of some and of the Infra-Lias of other geologists, are those that are associated with the great Coral-fauna of the Sutton Stone and of the equivalent deposits at Brocastle, in Glamorganshire.

The following Table shows the community of some well-known species in the coralliferous Liassic beds of Glamorganshire, and those of France and the Duchy of Luxembourg.

	Sutton Stone.	Southern-down.	Brocastle.	<i>Ammonites planoria</i> Zone. ¹	Calcaire de Valogne.	<i>Ammonites Burgundia</i> Zone. ²	<i>Ammonites angulatus</i> Zone. ²	Luxembourg, Grès calcaireux.
<i>Septastræa excavata</i> , E. de From.	*	...	*	...	*	...
<i>Montlivaltia polymorpha</i> , Terq.	*	...	*	*	...
— <i>pedunculata</i> , Dunc.	*	...	*
<i>Isastræa Sinemuriensis</i> , E. de From.	*	*	...
<i>Thecosmilia Martini</i> , E. de From.	*	...	*	...	*	...
— <i>Michelini</i> , Terq.	*	...	*
<i>Ammonites angulatus</i> , Schl.	*	*	...
<i>Cerithium acuticostatum</i> , Terq.	*	*	*	...	*	*
— <i>gratum</i> , Terq.	*	*	*	*
— <i>Semele</i> , D'Orb.	*	...	*	*	*	*
<i>Turritella Dunkeri</i> , Terq.	*	...	*	...	*	*
— <i>Zenkeni</i> , Dunk., sp.	*	...	*	...	*	*
<i>Littorina clathrata</i> , Desh.	*	*	*	*
<i>Phasianella Morencyana</i> , Piette	*	*	...
<i>Neritopsis exigua</i> , Terq.	*	...	*	*
<i>Gervillia acuminata</i> , Terq.	*	*	...
<i>Ostrea irregularis</i> , Münster (<i>O. liassica</i> , Strickland)	*	*	*	*	...	*	...	*
— <i>multicostata</i> , Münst.	*	*	*
— <i>anomala</i> , Terq.	*	...	*	...	*
<i>Lima tuberculata</i> , Terq.	*	*	*	*	*	*
<i>Cucullæa Hettangiensis</i> , Terq.	*	*	...
<i>Cardita Heberti</i> , Terq.	*	*	...
<i>Lima exaltata</i> , Terq.	*	*	*
— <i>dentata</i> , Terq.	*	*	*
<i>Cardinia regularis</i> , Terq.	*	*	*	*	*
<i>Plicatula intusstriata</i> , Emm.	*	*	...	*	...	*	*	*

¹ Terquem et Piette, op. cit.

² Côte d'Or.

The range in space and in time of some of these species is very remarkable. Several of them range from the Italian to the Welsh Lias, and from the Zone of *Avicula contorta* to that of *Ammonites Bucklandi*; but the general grouping of the Gasteropoda, Lamelli-branchiata, and Madreporaria indicates a Zoological Province which flourished anterior to the characteristic fauna of the time of *Gryphæa incurva* and *Ammonites Bucklandi*.¹

The richness of the Glamorganshire beds beneath the arenaceous deposits containing *Gryphæa incurva* in species and specimens is very evident. The Madreporaria are rare in the equivalent strata on the Continent.

IV. DESCRIPTION OF THE SPECIES FROM THE ZONE OF AMMONITES ANGULATUS AT MARTON, NEAR GAINSBOROUGH.

At Marton,² on the line of railway from Gainsborough, in Lincolnshire, to Lincoln, there are dull blue earthy and shelly limestones, which are very fossiliferous. These beds have been carefully searched for fossils, and a very rich and interesting fauna has been collected.³

They occupy a position above the White Lias and below the blue compact limestones of the *Ammonites Bucklandi* series.

The fauna is very characteristic, but the Madreporaria are allied rather to those of the equivalent beds of the Lower Lias in the North of Ireland and of the East of France than to the species at Brocastle and in the Sutton Stone.

1. MONTLIVALTIA HAIMEI, *Chapuis et Dewalque*. Pl. X, figs. 24—32.

"The corallum is simple, discoidal, and depressed; the base is very slightly pedicellate; the epitheca is very thin, ridged, and extends to the calicular margin.

"The calice is circular in outline, slightly or not at all convex, and the central fossa is small and circular.

"The septa are numerous, and form six cycles in six systems. The primary and secondary septa nearly reach the centre of the calice, and barely differ from those of the third cycle. The septa of the sixth cycle are very small. All the septa are thin, and their margin is strongly crenulate; those of the first and second cycles become thicker near the centre of the calice, and thinner at the periphery, where all the septa are about the same thickness." ('*Descript. des Foss. des Terr. Second. du Luxembourg*,⁴ Chapuis et Dewalque, p. 268.)

The resemblance of the species to a Cyclolite is noticed by MM. Chapuis and

¹ P. Martin Duncan, '*Quart. Jour. Geol. Soc.*,' Feb., 1867.

² F. M. Burton, Esq., F.G.S., and the Rev. B. Chamberlin, F.G.S., have given me information on this section.

³ Ralph Tate, Esq., F.G.S., "*On the Fossiliferous Development of the Zone of A. angulatus, &c.*," an unpublished paper from which I have obtained much information, and all my knowledge of the Molluscan fauna of Marton.

Dewalque; and they remark that the base is ordinarily slightly convex, but sometimes perfectly horizontal; moreover, they observe that the calice is more convex when the base is horizontal.

MM. de Fromentel and de Ferry have divided the species *Montlivaltia Haimeï* into three:

1. *Montlivaltia Haimeï*, Ch. et Dew.
2. ,, *tenuisepta*, From. et Ferry.
3. ,, *granigera*, From. et Ferry.

He doubts the propriety of admitting so great a variation in septal number and in septal ornamentation as must be tolerated if the species were left entire.

A very considerable series of specimens of the species has been examined, and the distinctness of such forms as those considered worthy of the specific names *tenuisepta* and *granigera* has not been satisfactorily determined. Like the recent simple corals, *Montlivaltia Haimeï* may have had a great variability. It was a very common species, and therefore all the more likely to vary in its shape, septal number, and ornamentation.

It is evident that there are forms of the species which are either concave or horizontal at the base; and others which are barely convex at the base, and which may become conical, sensibly taller than usual, and even cylindro-conical in shape. The convexity of the calice, or rather the exsertness of the septa, is often, but not always, correlative to this development of the base, and concave calices are not uncommon in the tallest corallites. The septal number varies in the development of part of the seventh cycle, and the dentate or crenulate condition of the septal edge is very variable.

The diameter of the calices and the height of the corallum depend upon the age of the individual.

It would appear that no British specimen exactly resembles the type from Jamoigne, but a variety from the Irish Lias at the Island Magee is nearer to it than any of the British forms.

Localities. Marton, near Gainsborough; Newark, Notts; east shore of Island Magee, North of Ireland. In the Collections of Rev. P. B. Brodie, Mr. Burton, Rev. Mr. Chamberlin, the Geological Society, and the British Museum.

2. MONTLIVALTIA PAFILLATA (sp. nov.). Pl. X, figs. 15—18.

The corallum is Cyclolitoid in shape, the base is slightly concave, and the calice is convex, there being a circular depression at the centre.

The epitheca of the base reaches to the calicular margin; it is very thin, is marked with concentric shallow depressions and elevations, and the costæ are seen through it faintly.

The calice is nearly circular.

The septa are exsert, and the larger have very large dentations or papillæ on them. The papillæ are small at the margin and at the columellary space, but midway there are six or more of them which are very prominent. There are twenty-four septa, which reach the margin of the columellary space, and they are strongly papillated. Between two of the longest septa there are three others, one, the central, is longer than the others, which are almost rudimentary; all are papillate. There are thus five complete cycles of septa, in six systems.

The columellary space presents several small papillæ, but they are septal. There is no columella.

Diameter of calice, $\frac{1}{10}$ ths inch. Height of corallum, $\frac{5}{16}$ ths inch.

Locality. Marton, near Gainsborough; east shore of Island Magee, in the North of Ireland. In the Collections of F. M. Burton, Esq., F.G.S., Gainsborough, and R. Tate, Esq., F.G.S.

3. *MONTLIVALTIA PAPILLATA* (sp. nov.). A variety. Pl. X, figs. 19—21.

The corallum is smaller than the type, and the papillæ are smaller and sharper.

Locality. Marton, near Gainsborough. In the Collection of Rev. B. Chamberlin, F.G.S.

4. *SEPTASTREA FROMENTELI*, *Terquem et Piette*. Pl. XI, fig. 5.

The corallum is massive, and resembles a flattened cone in shape.

The corallite walls are very thin, and are fused together.

The calices are polygonal, irregular in shape, and deep.

The septa are thin, finely dentate, and rather wavy; they number from twenty-four to twenty-six in small calices, and from fifty-two to sixty-two in the larger.

The fissiparous division of the calices is very constant, and occurs both in the midst of the calices and at their angles. It is very rare to observe calices which do not present evidences of fissiparity, so that the calices are almost always double.

Diameter of the calices, about $\frac{1}{3}$ rd to $\frac{2}{3}$ ds inch.

Locality. Marton, near Gainsborough; Harbury, Warwick; east shore of Island Magee, North of Ireland. In the Collections of F. M. Burton, Esq., F.G.S., and Ralph Tate, Esq., F.G.S.

The shape of the corallum is subject to variation, and the Marton specimens are massive and flat, whilst that from Harbury, belonging to Rev. P. B. Brodie, is very gibbous and irregular in shape. The specimens from the North of Ireland are also irregular in shape. The species has a considerable range, and it has been found by MM. Terquem et Piette¹ in the "Calcaire à *A. planorbis* de Volfsmuhl, près de Mondorf et de Beaufort." But in

¹ Terquem et Piette, op. cit., p. 129.

England and Ireland it occupies a higher zone, and is accompanied by *Montlivaltia Haimeï* and its varieties.

The following Cephalopoda, Gasteropoda, and Lamellibranchiata accompany the Madreporaria just described in the section at Marton:¹

- Ammonites Johnstoni*, Sow.
 „ *angulatus*, Schl.
Nautilus striatus, Sow.
Cerithium Semele, D'Orb.
Phasianella Morencyana, Piette.
Turbo subelegans, Münster.
Turritella Dunkeri, Terquem.
Cucullæa Hettangiensis, Terquem.
Anomia pellucida, Terquem.
Cardinia Listeri, Sow.
 „ *ovalis*, Stutch.
Cardita Heberti, Terquem.
Lima tuberculata, Terquem.
 „ *punctata*, Sow.
Pecten punctatissimus, Quenst.

The following is a list of the Madreporaria from the zone of *Ammonites angulatus* at Marton:

- Montlivaltia Haimeï*, Ch. et Dew.
 „ „ 2 varieties.
 „ *papillata*, Duncan.
 „ „ a variety.
Septastræa Fromenteli, Terquem et Piette.

V. DESCRIPTION OF THE SPECIES FROM THE ZONE OF AMMONITES ANGULATUS IN THE NORTH OF IRELAND.

In the subdivision of the Lias at Waterloo, Larne, where the Cephalopoda and Mollusca about to be mentioned are found, there is a very remarkable coral which cannot be classified with any of the genera of the Astreidæ. I have founded the new genus *Oppelismilia* to receive this species and another which belongs to the Lias at Harbury, and which will be described in the next part of this Monograph.

In the *Ammonites angulatus* Zone on the east shore of Island Magee there are several species of Madreporaria.

¹ List furnished by Ralph Tate, Esq., F.G.S., as was also that at p. 40.

Montlivaltia Haimci, Ch. et Dew., is found there, and the form has a greater resemblance to the Belgian type than to the specimens from Marton. The multiseptate and granular varieties of the species are also found.

Montlivaltia papillata, Duncan, is noticed amongst the Irish coral-fauna, and *Septastræa Fromenteli*, Terquem et Piette, also.

The Coral-fauna of the Zone of *Ammonites angulatus* of Lincolnshire is clearly strongly represented in the North of Ireland, and the Mollusca which accompany the Corals of the first locality are noticed to be associated with those of the last.

There is a *Montlivaltia* of the *Montlivaltia papillata* type which is special to the Irish Lias. *Oppelismilia gemmans* is not found in any other locality than Waterloo, Larne.

Genus—OPPELISMILIA.

The corallum is simple, attached, and conical. The epitheca is well marked, and reaches to the calicular margin.

The calice is shallow, and the septa are numerous and close. There are no costæ, and there is no columella. Gemmation occurs within the calice, and the bud, which has an epitheca, grows with the parent.

The genus thus includes *Montlivaltia* with calicular gemmation.

OPPELISMILIA GEMMANS (sp. nov.). Pl. X, figs. 33, 34.

The corallum is short; it has a broad and flat calice, an oval space at the base where it was once adherent; a strong epitheca, with circular markings, and there are no costæ.

The calice is flat and shallow, and its margin is sharp.

The septa are very numerous and unequal.

The bud on the calice has an epitheca, and its septa are faintly dentate.

Height of the corallum, $\frac{3}{10}$ ths inch. Width of the calice, $\frac{9}{10}$ ths inch.

Locality. Waterloo, Larne, North of Ireland. In the Collection of Ralph Tate, Esq., F.G.S.

The following new *Montlivaltia* is also from the Lias of Ireland:

MONTLIVALTIA HIBERNICA (sp. nov.). Pl. X, figs. 22, 23.

The corallum is discoidal, the base is flat, and the calice is convex.

The epitheca of the base is strongly marked concentrically.

The septa are numerous, close, unequal, and are marked by small papillæ, which are very close together, and by flat eminences, which are also very close together. There appear to be nearly five cycles of septa, and the largest septa are papillose.

The diameter of the calice is $\frac{4}{10}$ ths inch, and the height of the corallum $\frac{1}{10}$ th inch.

Locality. The eastern shore of Island Magee, in the North of Ireland. In the Collection of Ralph Tate, Esq., F.G.S.

LIST OF SPECIES OF MADREPORARIA FROM THE ZONE OF AMMONITES ANGULATUS IN THE NORTH OF IRELAND.

1. *Oppelismilia gemmans*, Duncan.
- Montlivaltia Haimeii*, Ch. et Dew.
- " " varieties.
- " *papillata*, Duncan.
- " *Hibernica*, Duncan.
- Septastræa Fromenteli*, Terquem et Piette.

The following Cephalopoda, Gasteropoda, and Lamellibranchiata were found associated with the Madreporaria in the zone of *Ammonites angulatus* of the North of Ireland:

- Ammonites Johnstoni*, Sow.
- " *angulatus*, Sch.
- Nautilus striatus*, Sow.
- Actæonina fragilis*, Dunk.
- Cerithium Semele*, D'Orb.
- " *gratum*, Terquem.
- Phasianella Morencyana*, Terquem.
- Pleurotomaria cæpa*, Terquem.
- Turbo subelegans*, Münster.
- Turritella tenuicosta*, Portl.
- Pecten calvus*, Goldf.
- Plicatula Hettangiensis*, Terquem.
- " *intusstriata*, Emm.
- Terebratula perforata*, Piette.
- Avicula Sinemuriensis*, D'Orb.
- Cardinia Listeri*, Sow.
- " *ovalis*, Stutch.
- Cardium Philippianum*, Dunk.
- Lima acuticosta*, Münster.
- " *tuberculata*, Terquem.
- Ostrea irregularis*, Münster.

VI. DESCRIPTION OF THE SPECIES FROM LUSSAY IN THE ISLE OF SKYE.

Dr. T. Wright has described the Coral-bed of the Lower Lias of Skye, and the species of *Isastræa* which, grouped in masses, appears to be the only Coral found there. It is most probable, from the position of this coral-bed,¹ and the association of *Ostrea arietis* and *Cardinia concinna* with it (in the bed beneath), that *Isastræa Murchisoni* belongs to the same geological horizon as the Liassic deposit at Brocastle and the Sutton Stone.

ISASTRÆA MURCHISONI, Wright. Pl. XI, figs. 1—4.

Dr. Wright's description of this species gives the following characters :

Corallum large, massive, convex. Calices unequal, deep, polygonal; sides unequal. Margin thin. Septa, 30 to 36, and even 40 or more in the large calices; unequal in length, thin, waved, granulated superiorly. Columella absent; point of convergence of septa excentral. Diameter of calices, $\frac{3}{10}$ ths to $\frac{4}{10}$ ths inch. Depth of fossa, $\frac{2}{10}$ ths inch.

Locality. Lussay, Skye.

The surface of the type specimen is very uneven; the calices are very irregular in size, shape, and depth, and the margins are not even. Thus one calice may be on a higher level than those to which it is attached, and often so much so that there is a faint trace of a subsequent growth of wall. The septa are very irregular in their number, and the longest have one or more teeth at their inner end. There is often a ridge between the margin of the calice and the centre, indicating calicinal gemmation, but the gemmation of the corallum usually takes place at the margin, and there is no fissiparity. No cyclical arrangement of the septa can be distinguished.

The large and shallow calices, thin septa, the peculiar relation of contiguous calices, and the sharp elevated margins, distinguish this species, which is allied rather to a new genus from the Middle Lias of Pabba, *Lepidophyllia* (Duncan), than to any of the Liassic *Isastrææ*.

¹ See Mr. Geikie's memoir "On the Geology of Strath, Skye;" with "Descriptions of Fossils," by Dr. T. Wright, 1857, 'Quart. Journ. Geol. Soc.,' vol. xiv, pp. 1 *et seq.* There is a most interesting description of the Coral-bed in the Isle of Skye by Hugh Miller, in his "Essay on the Corals of the Oolitic System of Scotland," read before the Royal Physical Society of Edinburgh, and published in 'The Old Red Sandstone,' 7th edition, 1859.

² 'Quart. Journ. Geol. Soc.,' vol. xiv, p. 34.

VII. LIST OF THE SPECIES DESCRIBED IN THIS PART FROM THE ZONES OF
AMMONITES PLANORBIS AND AMMONITES ANGULATUS.

1. *Oppelismilia gemmans*, Duncan.
2. *Montlivaltia Walliæ*, „
3. — *Murchisoniæ*, „
4. — *polymorpha*, Terquem et Piette.
5. — *parasitica*, Duncan.
6. — *simplex*, „
7. — *brevis*, „
8. — *pedunculata*, „
9. — *Haimeï*, Chapuis et Dewalque.
10. — *papillata*, Duncan.
11. — *Hibernica*, „
12. *Thecosmilia Suttonensis*, „
13. — *mirabilis*, „
14. — *serialis*, „
15. — *rugosa*, Laube.
16. — *Brodiei*, Duncan.
17. — *Martini*, E. de Fromentel.
18. — *Michelini*, Terquem et Piette.
19. — *irregularis*, Duncan.
20. — *Terquemi*, „
21. — *affinis*, „
22. — *dentata*, „
23. — *plana*, „
24. *Rhabdophyllia recondita*, Laube.
25. *Astrocœnia gibbosa*, Duncan.
26. — *plana*, „
27. — *insignis*, „
28. — *reptans*, „
29. — *parasitica*, „
30. — *pedunculata*, „
31. — *costata*, „
32. — *favoidea*, „
33. — *superba*, „
34. — *dendroidea*, „

35. *Astrocænia minuta*, Duncan.
36. — *Sinemuriensis*, D'Orbigny, sp.
37. *Cyathocænia dendroidea*, Duncan.
38. — *incrustans*, „
39. — *costata*, „
40. *Elysastræa Fischeri*, Laube.
41. — *Moorei*, Duncan.
42. *Septastræa excavata*, E. de Fromentel.
43. — *Haimeï*, Wright, sp.
44. — *Fromenteli*, Terquem.
45. *Latimæandra denticulata*, Duncan.
46. *Isastræa Sinemuriensis*, E. de Fromentel.
47. — *globosa*, Duncan.
48. — *Murchisoni*, Wright.

Varieties of *Thecosmilia irregularis*, Duncan.

- *Montlivaltia Haimeï*, Chapuis et Dewalque.
 — — *papillata*, Duncan.
-

PLATE I.

LIASSIC CORALS FROM STREET AND BROCASTLE.

FIG.

1. *Septastræa Haimci*, Wright, sp. (P. 5.)
2. The base of the corallum.
3. Calices, magnified.
4. Fissiparous calice, magnified.
5. Septa, magnified.
6. *Septastræa excavata*, E. de From. (P. 32.) A calice, magnified.
7. The usual appearance of longitudinal sections in the Brocastle beds, magnified.



PLATE II.

LIASSIC CORALS FROM THE SUTTON STONE.

FIG.

1. *Thecosmilia rugosa*, Laube. (P. 13.)
2. Its calice, magnified.
3. A fissiparous calice, magnified.
4. A corallite, magnified.
5. Part of the wall, some septa, and some dissepiments, magnified.
6. A deformed corallite.
7. *Rhabdophyllia recondita*, Laube. (P. 17.)
8. Part of its transverse section, highly magnified, to show the septal arrangement.
9. The costæ, magnified. The corallite has *Astrocænia parasitica* upon it.
10. *Thecosmilia mirabilis*, Duncan. (P. 12.)
11. A calice, highly magnified.
12. *Montlivaltia pedunculata*, Duncan. (P. 10.)
13. Its costæ and epitheca, magnified.
14. }
15. } Peduncles of *Thecosmiliæ*.
16. }



PLATE III.

LIASSIC CORALS FROM BROCASTLE.

FIG.

1. *Thecosmilia irregularis*, Duncan. (P. 15.)
2. Its upper surface, magnified.
3. Its epitheca, calices, and base, magnified.
4. A circular calice, magnified.
5. Septa (upper margin), magnified.
6. Side view of a septum, with terminal tooth.
7. *Thecosmilia Terquemi*, Duncan. (P. 16.)
8. Its base, magnified; the epitheca has been worn, and the costæ are seen with dissepiments.
9. Its upper surface, magnified.
10. } Its calices, magnified.
11. }
12. A side view of a septum, magnified.
13. A variety of *Thecosmilia irregularis*, Duncan. (P. 15.)
14. Its calice, magnified.
15. A side view of a septum, magnified.
16. *Montlivaltia simplex*, Duncan. (P. 9.)
17. Its calice, magnified.
18. *Thecosmilia affinis*, Duncan. (P. 16.)
19. A calice, magnified.
20. A side view of a septum, magnified.
21. *Thecosmilia dentata*, Duncan. (P. 16.)
22. Its calice, magnified.
23. A septum, magnified.
24. *Thecosmilia plana*, Duncan. (P. 17.)
25. Part of its calice, magnified.



PLATE IV.

LIASSIC CORALS FROM THE SUTTON STONE.

FIG.

1. *Cyathocænia incrustans*, Duncan. (P. 28.)
2. Some calices, magnified.
3. Casts of *Astrocænia gibbosa*, Duncan. (P. 18.)
4. *Astrocænia reptans*, Duncan. (P. 20.)
5. } Its calices, magnified.
15. }
6. Calices altered by fossilization, magnified.
7. *Thecosmilia Suttonensis*, Duncan. (P. 11.)
8. Side view of the corallum.
9. A calice, magnified.
10. *Thecosmilia serialis*, Duncan. (P. 12.)
11. Upper surface of the corallum.
12. A serial calice, magnified.
13. *Montlivaltia parasitica*, Duncan. (P. 9.)
14. Its calice, magnified.

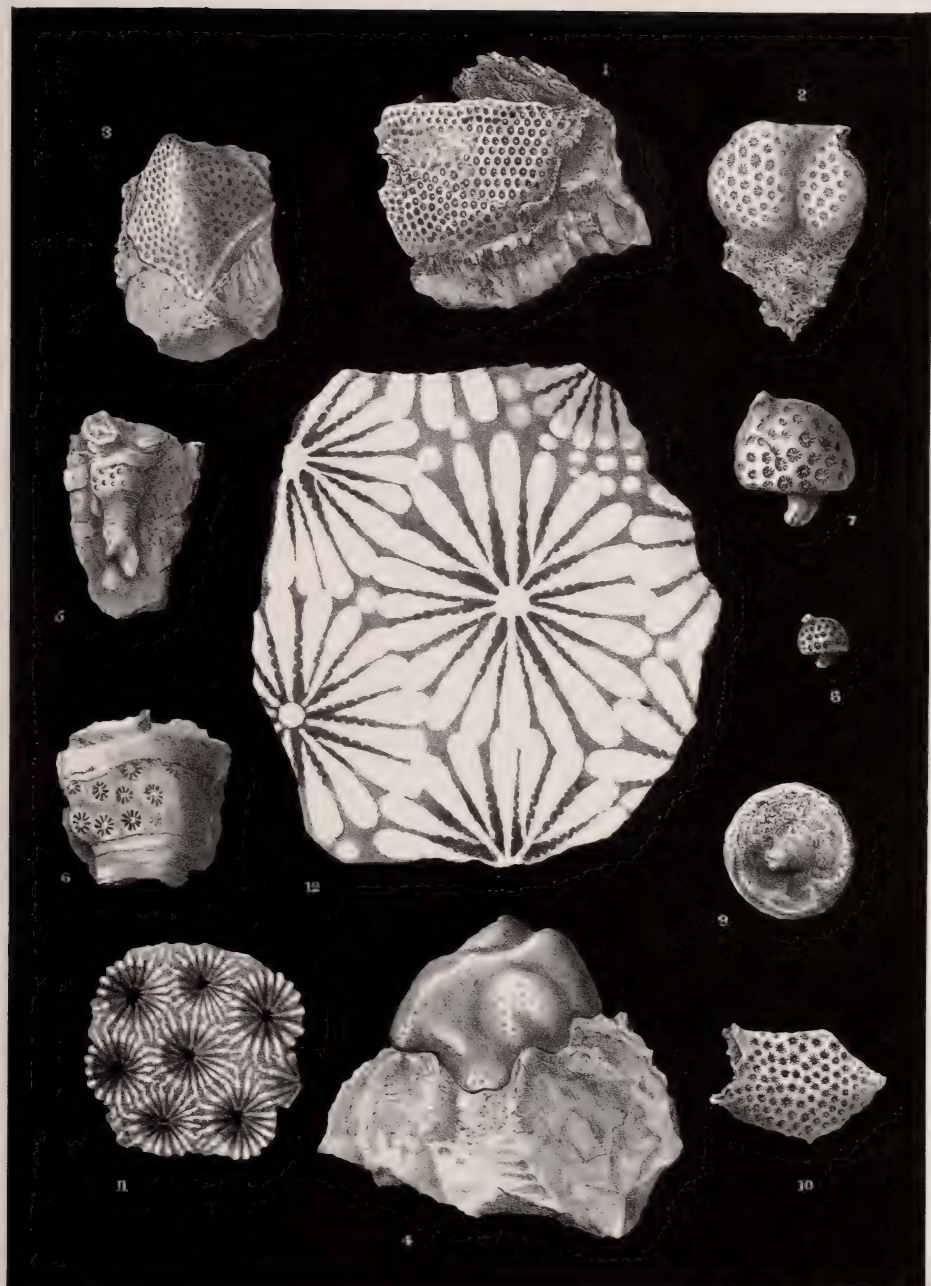


PLATE V.

LIASSIC CORALS FROM THE SUTTON STONE AND BROCASTLE.

FIG.

1. *Astrocænia plana*, Duncan. (P. 19). The corallum, natural size.
2. *Astrocænia gibbosa*, Duncan. (P. 18.) A corallum, with much cœenchyma.
3. A corallum somewhat worn.
4. The usual appearance of the Coral in the Sutton Stone; all the calices have been worn away, and it requires some trouble to distinguish the fossil.
12. A section at right angles to the corallites, highly magnified. The columella, the faint lateral dentations of the septa, and the round ornamentation between the costal ends are shown.
5. *Astrocænia parasitica*, Duncan. (P. 20.)
6. The same, magnified. The Coral is parasitic on *Rhabdophyllia recondita*.
7. *Astrocænia pedunculata*, Duncan. (P. 20.) The corallum, magnified.
8. The corallum, natural size.
9. A view of the peduncle and base, magnified.
10. *Cyathocænia costata*, Duncan. (P. 29.) The corallum, natural size.
11. Some calices, magnified.



LIASSIC CORALS

PLATE VI.

JURASSIC CORALS FROM THE SUTTON STONE AND BROCASTLE.

FIG.

1. *Astrocœnia gibbosa*, Duncan. (P. 18.) Some calices, magnified, showing a very usual state of preservation.
2. A worn calice, magnified.
3. A side view of worn calices, showing the dense intermediate tissue, and faint traces of endotheca, magnified.
4. A side view of a calice, magnified.
5. *Elysastræa Fischeri*, Laube. (P. 29.) A transverse section of part of the corallum, slightly magnified.
6. A transverse section showing some corallites not united by their walls.
7. The septa of neighbouring calices, the walls being united, magnified.
8. Corallites which are separate, and covered with epitheca, magnified.
9. This is a diagram, and shows the plan of the genus.
10. *Elysastræa Moorei*, Duncan. (P. 30.) Upper surface of corallum.
11. A calice, magnified.
12. }
14. } " "
13. United calices, magnified.
15. A corallite, showing costæ, the epitheca having been worn off.

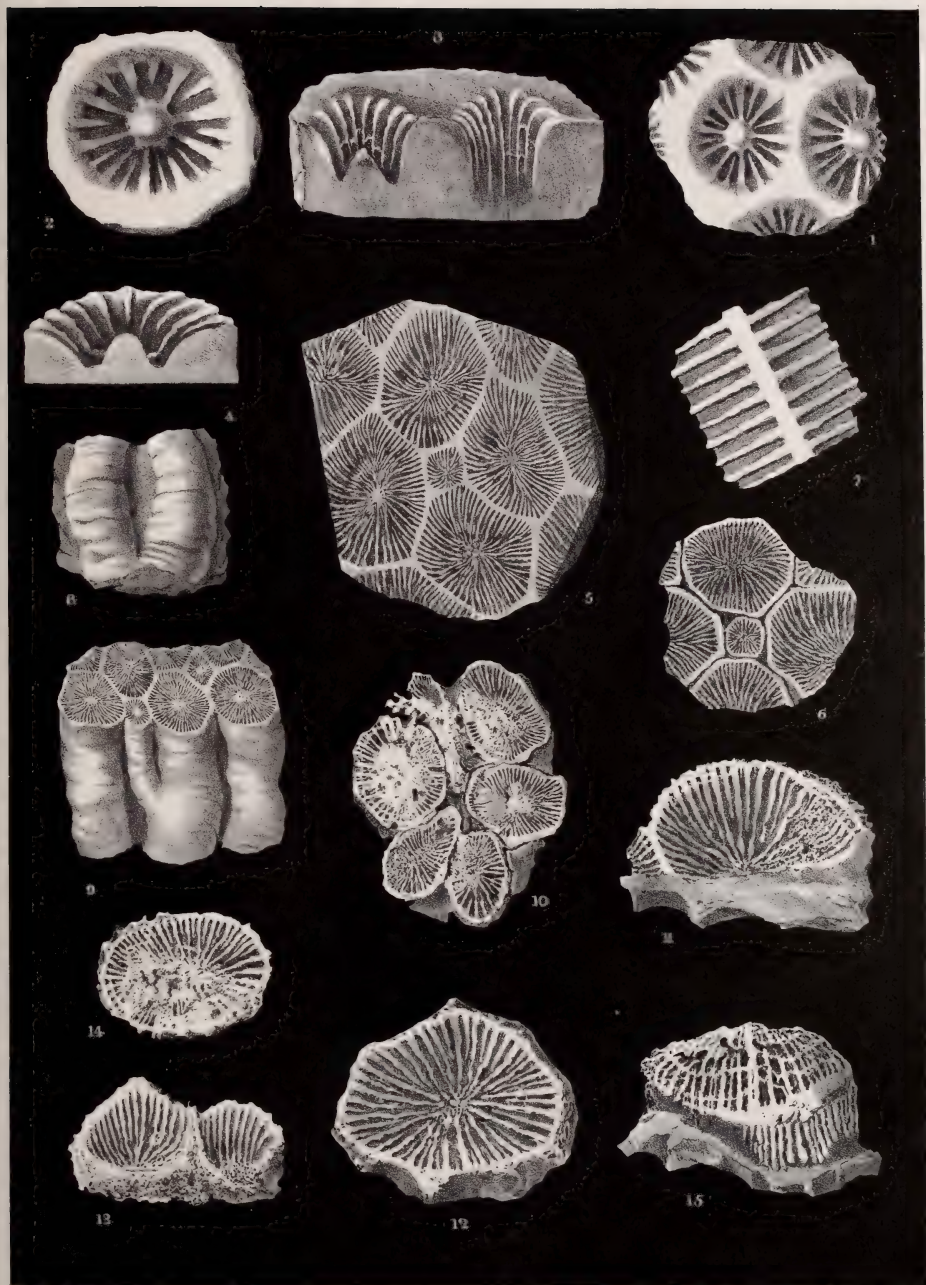


PLATE VII.

LIASSIC CORALS FROM BROCASTLE.

FIG.

1. *Isastræa Sinemuriensis*, E. de From. (P. 30.)
2. The upper part of its corallum.
3. The calices slightly magnified to show the marginal gemmation.
4. Another view.
5. } Calices, magnified.
6. }
7. Septa, magnified.
8. A corallum with larger calices than is usual.
9. Calices, magnified.
10. *Thecosmilia Michelini*, Terquem et Piette. (P. 14.) A large variety.
11. Its calice.
12. A corallum bifurcating.
13. Its calice, magnified.
14. *Montlivaltia polymorpha*, Terquem et Piette. (P. 8.) A fractured corallum.
15. A transverse section, magnified.

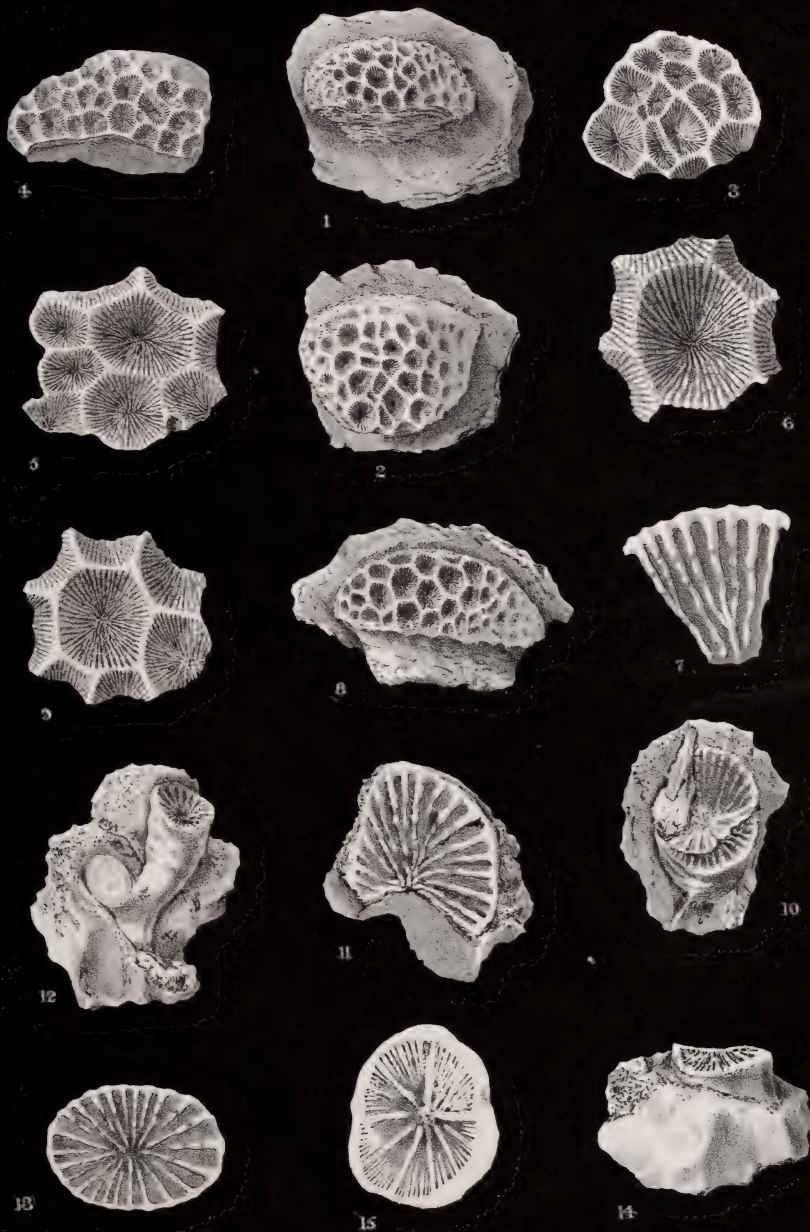


PLATE VIII.

LIASSIC CORALS FROM THE SUTTON STONE AND FROM BROCASTLE.

FIG.

1. *Montlivaltia polymorpha*, Terquem et Piette. (P. 8.) A long and large specimen.
2. A part of its transverse section, magnified.
3. Exothecal and endothecal dissepiments, costæ, and septa, magnified.
4. A smaller corallum.
13. Two corallites springing from a common base.
14. Septa of a young corallite, magnified.
15. Costæ and exotheca of a young corallite, magnified. (See also Pl. VII, figs. 14 and 15.)
5. *Montlivaltia Walliæ*, Duncan. (P. 7.) A corallum in the rock.
6. A calice, slightly magnified.
7. A side view of a septum, magnified.
8. *Montlivaltia brevis*, Duncan. (P. 10.) A corallum on the rock.
9. A calice, magnified.
10. *Montlivaltia Murchisoniæ*. (P. 8.) A corallum.
11. A part of the calice, magnified.
12. The peculiar costal arrangement and septa, magnified.
16. *Montlivaltia pedunculata*, Duncan. (P. 10.) A corallum.
17. *Isastræa globosa*, Duncan. (P. 31.) A corallum, the calices are worn.
18. Calices, magnified.

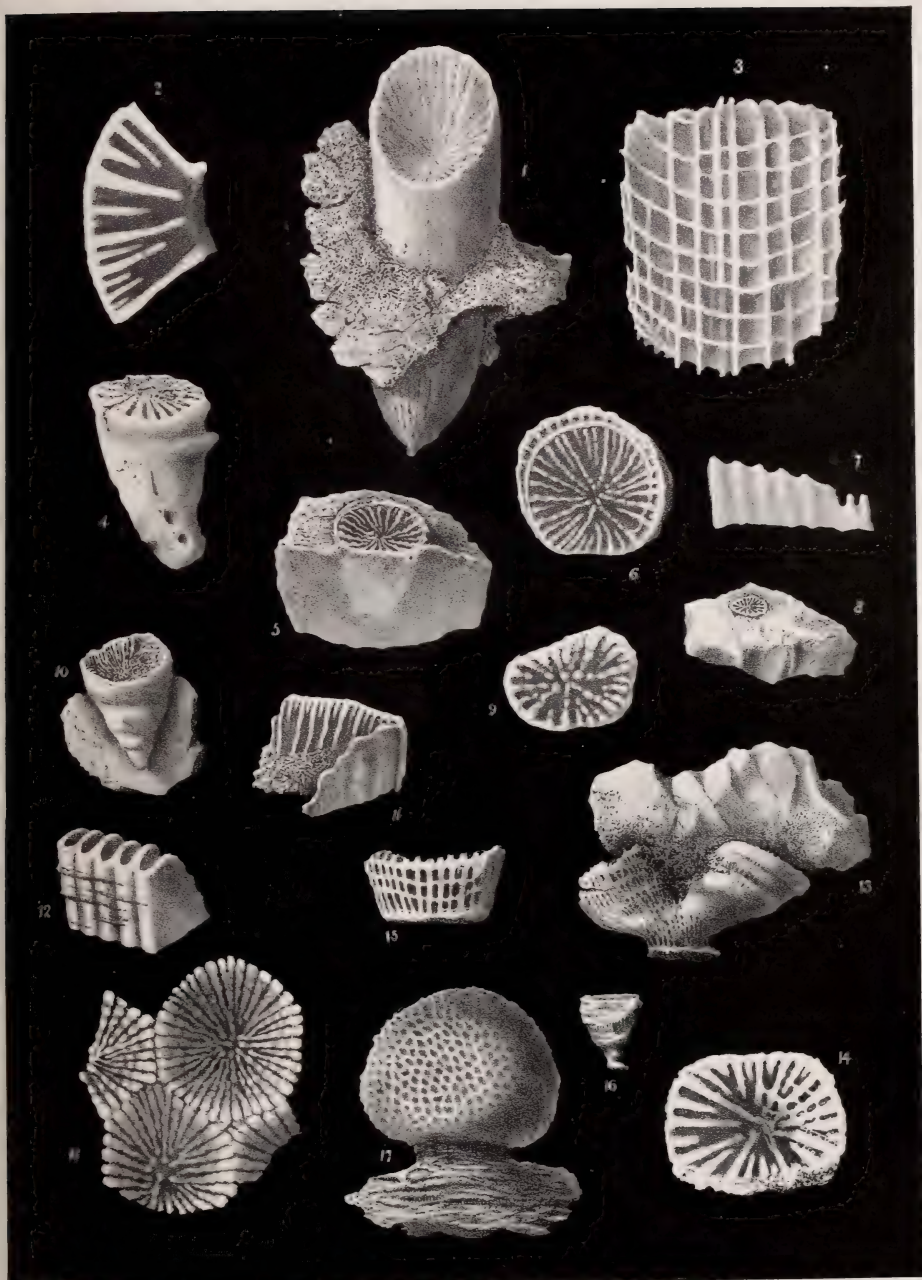


PLATE IX.

LIASSIC CORALS FROM BROCASTLE.

FIG.

1. *Astrocænia insignis*, Duncan. (P. 19.) A corallum.
2. Calices, magnified.
3. *Astrocænia superba*, Duncan. (P. 21.) Part of a corallum.
4. A calice, magnified.
5. A side view of a calice, magnified.
6. *Cyathocænia dendroidea*, Duncan. (P. 27.) A corallum.
7. A calice, magnified.
8. A calice, magnified ; a side view.
9. A transverse section of a stem, showing the concavities produced by the calices and the intermediate cœnenchyma.
10. *Astrocænia dendroidea*, Duncan. (P. 22.) A part of a corallum.
11. A calice, magnified.
12. *Astrocænia favoidea*, Duncan. (P. 21.) A corallum.
13. Calices, magnified.
14. A side view of a calice, magnified.
15. *Astrocænia costata*, Duncan. (P. 21.) A corallum.
16. Calices, magnified.
17. A corallum.
18. *Astrocænia minuta*, Duncan. (P. 22.) A corallum.
19. A calice, magnified.
20. A side view of a calice, magnified.

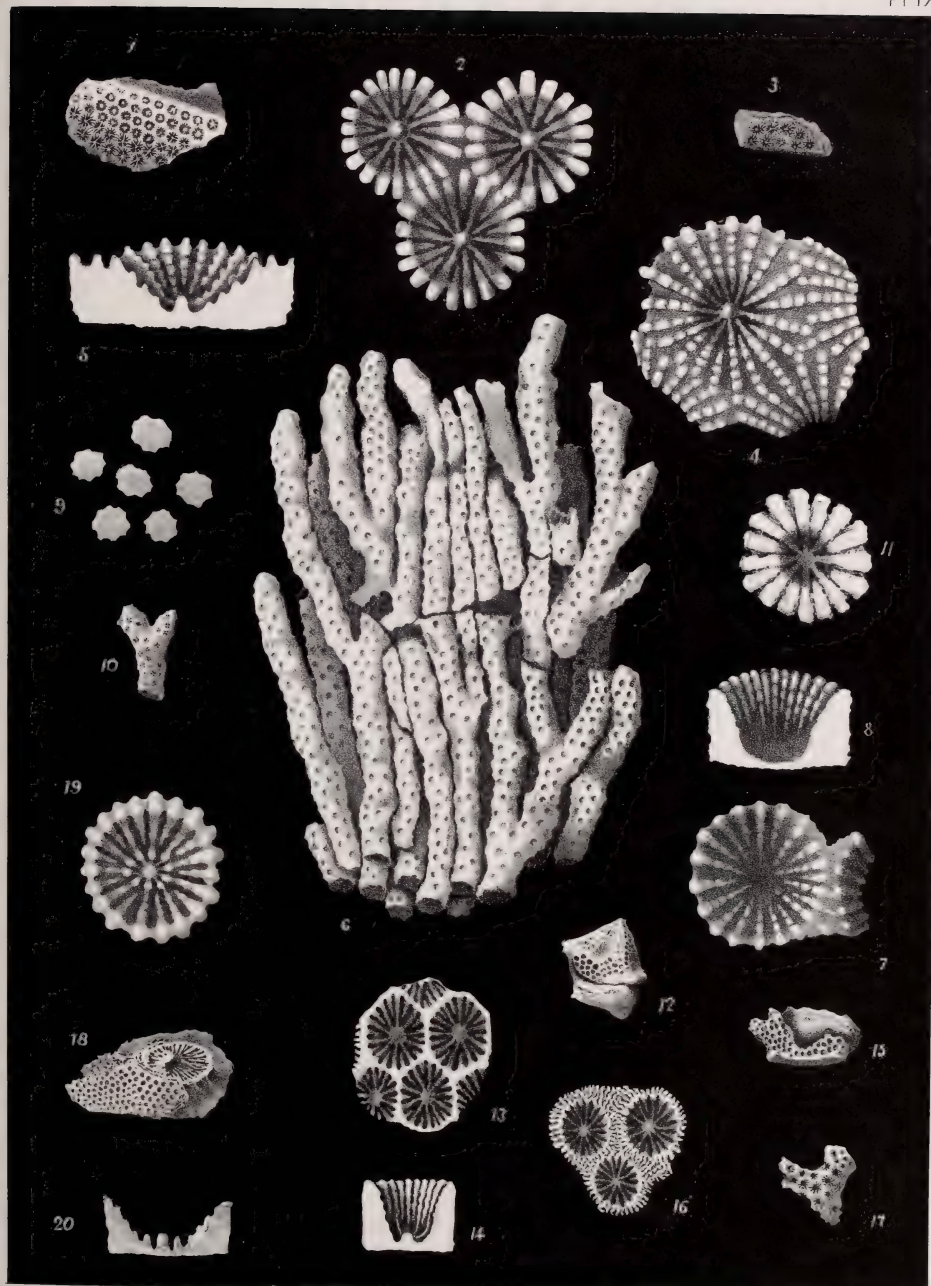




PLATE X.

CORALS FROM BROCASTLE ; MARTON, NEAR GAINSBOROUGH ; NEWARK, IN NOTTINGHAMSHIRE ;
AND FROM THE NORTH OF IRELAND.

FIG.

1. *Thecosmilia Brodiei*, Duncan. (P. 13.) The upper part of a corallite, natural size.
2. The calice, magnified.
3. A side view of a septum, magnified.
4. A septum seen from above, magnified.
5. Some corallites of *Thecosmilia irregularis*, Duncan. (P. 15.) Showing the gemmation from the calicular edge, and the rough and ridged epitheca.
6. A corallite of *Thecosmilia Martini*, E. de From. (P. 14.)
- 7 and 8. Views of its transverse section and calice, magnified.
9. Corallites, with strong epitheca.
10. A section of a cast of *Thecosmilia Michelini*, Terquem. (P. 14.) From Cowbridge, magnified.
11. The calicular end of a corallite.
12. The calice, magnified.
13. A corallite, showing the rounded ridges of the epitheca.
14. A calice.
15. The upper surface of *Montlivaltia papillata*, Duncan. (P. 36.)
16. A side view of the calice.
17. Septal dentations, magnified.
18. The base of the corallum.
19. *Montlivaltia papillata*, Duncan, variety. (P. 37.) Its calice.
20. The side of the calice.
21. The septa seen from above, magnified.
22. *Montlivaltia Hibernica*, Duncan. (P. 39.) Its calice.
23. The septa seen from above, magnified.
24. *Montlivaltia Haimeii*, Chapuis et Devalque. (P. 35.) The Irish form. View of the calice.
25. The septa seen from above, magnified.
26. A variety of *Montlivaltia Haimeii*. The calice.
- 27 and 28. Views of the corallum.
29. A variety of *Montlivaltia Haimeii*. The calice.
30. The side view of the corallum.
- 31 and 32. Unusual shapes of the corallum.
33. *Oppelismilia gemmans*, Duncan. (P. 39.) The calicular surface, showing calicular gemmation.
34. The side view of the corallum.

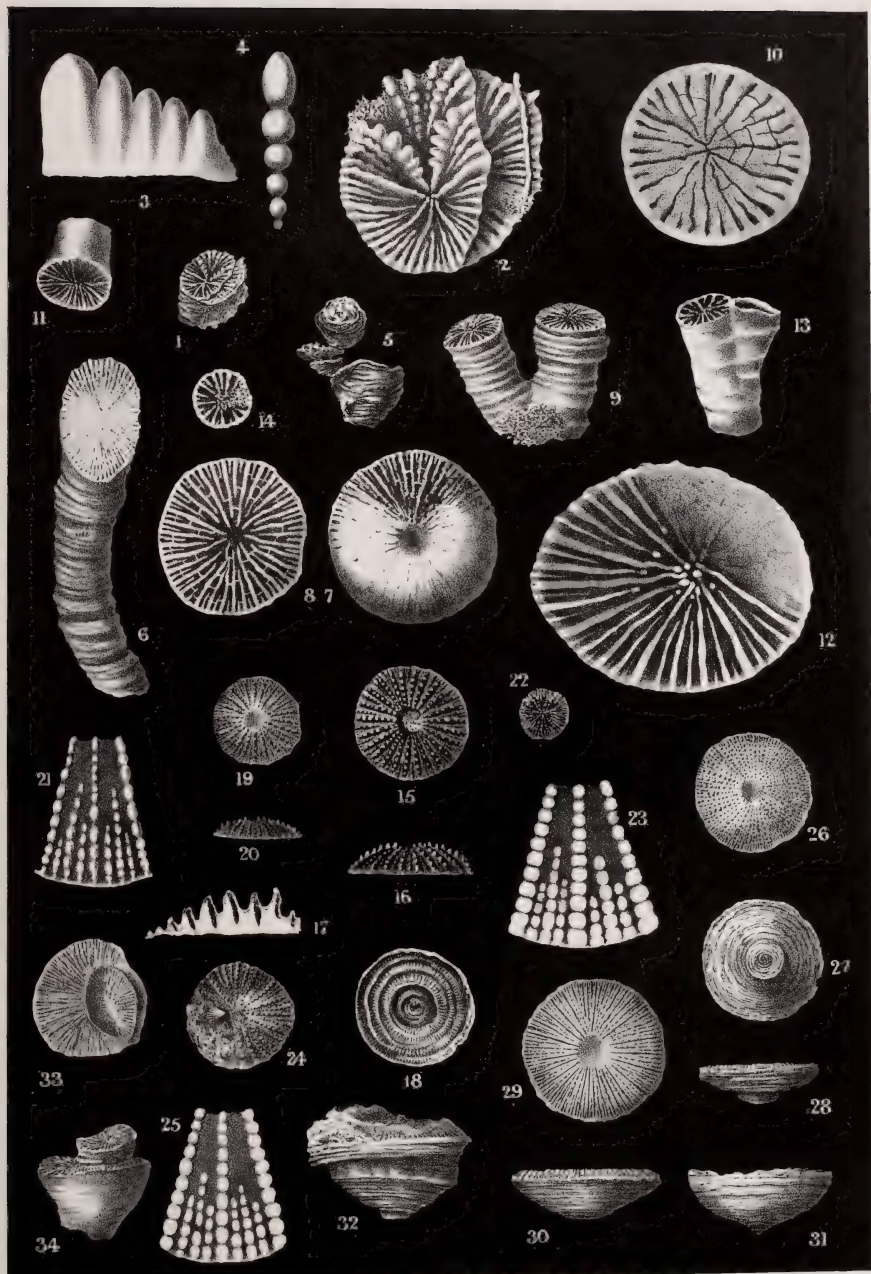
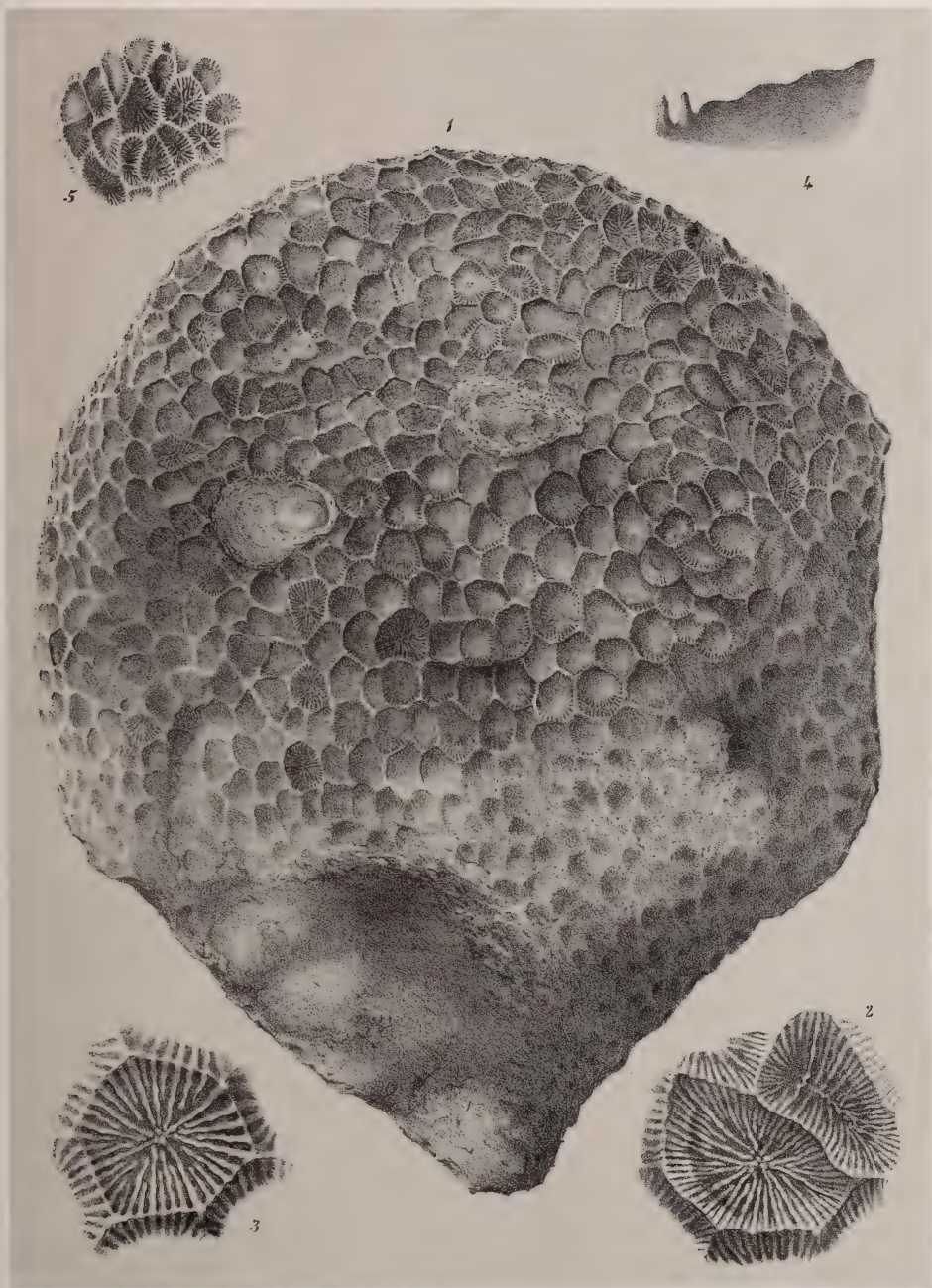


PLATE XI.

LIASSIC CORALS FROM LUSSAY, IN SKYE, AND MARTON, NEAR GAINSBOROUGH.

FIG.

1. *Isastræa Murchisoni*, Wright. (P. 41.)
2. Calices, magnified.
3. A calice, magnified.
4. A septum, magnified.
5. *Septastræa Fromenteli*, Terquem et Piette. (P. 37.) Some fissiparous calices, slightly magnified.



THE
PALÆONTOGRAPHICAL SOCIETY.

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VOLUME FOR 1866.

LONDON:

MDCCCLXVII.

A MONOGRAPH
OF
BRITISH TRILOBITES.

BY
J. W. SALTER, A.L.S., F.G.S.,

LATE OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

PART IV,
CONTAINING
PAGES 177 TO 216; PLATES XXV* TO XXX.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1867.

NOTICE TO CORRESPONDENTS.

IN our next part it would be in some respects advisable to go on with the highest and most compact group of the smooth-eyed Trilobites (see p. 2), viz. the *Proetida*, which comprise the Carboniferous species; but though materials are abundant, they are not complete, and the specimens are much scattered; I shall therefore, in Part V, after the *Bronteida* are finished, proceed with the lower groups, viz.—

ÆGLINIDÆ—given at p. 124 as a subgroup of the *Asaphida*, but possibly distinct, and certainly much lower than the others.

TRINUCLEIDÆ—for which materials are in plenty.

AGNOSTIDÆ—now of many species.

With these we shall close the First Volume.

IN Vol. II it is proposed to follow the left-hand column (p. 2), through the “primordial” genera of the *Olenida* and *Conocephalida*, which are already numerous, and will be still better known by that time; then to take up the more aberrant groups—*Lichada*, *Acidaspidæ*, *Harpedidæ*, &c. This will lead us to the *Cyphaspidæ*, before describing the *Proetida*: and there is an intimate relation between the two last-named groups, in spite of the numerous free body-rings which characterize the one, but which are soldered into a large post-abdomen or tail-piece in the highest and terminal forms of the *Proetida*,—viz.: the Carboniferous species of *Phillipsia*, &c.

I beg to thank our numerous friends for their ready help. Many additional species of the groups already passed in review have, of course, turned up; but these will best appear in the Appendix to Vol. II, should health and leisure be granted me to complete the work. If not, I shall have indicated, I hope, the right path for my successor.

Our friends, therefore, will please to communicate all their best specimens (with strict localities) of the three groups above mentioned. They may be left at the Geological Society; or forwarded to me at 45, Great Russell Street, or to—

8, Bolton Road, St. John's Wood, London.

April 29th, 1867.

J. W. SALTER.

ASAPHIDÆ—continued: OGYGIA, &c.

As must sometimes happen, in writing a continuous monograph, new materials, connected with plates and descriptions already completed, turn up just as the work has passed through the press; and if such material refer to plates long since issued, it would be of course desirable to leave the new matter to the end of the work; but if not too far removed, it is as well to insert it as nearly as possible in its place.

Before proceeding, therefore, to the description of *Illænus*, to which group the present part of the Monograph is restricted, we give a plate (numbered Pl. XXV*) of *Ogygia peltata*, containing the new and more perfect specimens to which reference has been made in the "Corrigenda" of the volume for 1864. A new species has also occurred in the same locality, and from the same formation (the Arenig or Skiddaw Rock, a set of beds but little known). I had better describe the two forms of *Ogygia* together; I take also the opportunity of inserting a new *Barrandia* at the same time.

OGYGIA PELTATA, *Salter* (Pl. XVII, figs. 8—10). Pl. XXV*, figs. 1—4.

In page 133, line 1, it was stated that on Pl. XVII, figs. 9 and 10 are wrongly marked as *O. peltata*; and in page 134, our fig. 10 was described as *O. scutatriæ*, a species which is only yet known from the Tremadoc Rocks.

The mistake arose, as stated in the Corrigenda, from laying too much stress on the broad form and broad axis of the female form ('*forme large*' of Barrande), which in *Ogygia peltata* resemble those of *O. scutatriæ*: and, following the same idea, the head of the broad form, with its wide labrum, was also described as *O. scutatriæ* (p. 133, line 22, &c.).

These mistakes are now rectified by the accompanying plate (Pl. XXV*), which exhibits fine specimens of the broad form (figs. 2, 4); the shape of the head, with its oblong parallel-sided glabella, in fig. 1; and the labrum, of full size (fig. 3). The eyes, it will be observed, approach the glabella closely, as in Pl. XVII, fig. 10, and are not placed wide apart, as in fig. 8 of that plate, which, copied from the best reconstruction I could formerly give of the species, gives an incorrect idea of all but the general proportions. The fulcrum-points of the axis, &c., are also imperfect, so we had better erase the figure entirely. It is not very pleasant to admit so many errors, but it is a shorter plan than trying to defend or excuse them. The description in page 135 is more correct; but the glabella is not so wide as the cheeks, nor the axis of the thorax as the pleuræ; and these latter have the fulcrum placed at less than one half out instead of two-thirds. The pleural groove is nearly straight, only a little sigmoid; and the tips are truncate, not

falcate. The groove ends abruptly a little way within the tip. In the tail eight furrows cross the axis, the last three not quite complete. The interlining furrows are certainly not so long nor so distinct as in our former description and figure.

The following is the new form which occurs with *O. peltata* at St. David's:

OGYGIA BULLINA, n. sp. Pl. XXV*, fig. 5.

O. plana, modica, biuncialis, capite semicircularato, fronte latiori, angulis—? Glabella pyriformis, ad basin angustata, lobisque basalibus inflatis; genæ absunt. Oculi prope glabellam, in medio capite positi. Thorax axe angustissimo, pleuris rectis, fulcro ultra medium posito. Cauda? Labrum?

A neat species, which was sent by my correspondent Henry Hicks, Esq., of St. David's, from the beds at Whitesand Bay.

The form is broad-oval. We have but the head, without free cheeks, and eight or nine of the body-rings, but there is enough to show that the fossil is quite new. The head is broader than a semicircle, and has a wide, coarsely striated front (the squamate striæ are not visible in our figure); a pyriform glabella, inflated in front; strong basal obliquely oval lobes, projecting beyond the neck of the glabella, and separated from it by rather strong lines. Neck-furrow of the glabella tolerably strong, and much broader than that beneath the cheeks. Eye-lines above and below the eye widely diverging; the eye short, and placed about halfway up the head, but even closer to the glabella than in *O. peltata*, which species accompanies it. Beneath the eye the suture curves so largely out that it must nearly reach the angle of the head. We have not the free cheeks, and of course do not know anything of the spines; I suppose these must have been short.

Thorax with a very narrow and somewhat prominent axis, which is about half as wide only as the flat pleuræ, and these are nearly direct; the slight fulcrum, placed beyond the half of the pleura, being scarcely an angular bend at all. The facet, however, is very distinct and sharp-edged. Fine curved transverse striæ cover closely the glabella, and are traceable on the axis of the thorax. The much coarser striæ on the fascia beneath the pleuræ range up to the fulcrum, but not within it.

Locality.—ARENIG ROCKS. North-east angle of Whitesand Bay, St. David's (Woodwardian Museum, Cambridge). The species should be sought for in the same beds on Ramsey Island.

My lamented friend Mr. H. Wyatt-Edgell found a new *Barrandia* in the black shales of Aberciddy Bay. (For this genus, see p. 137, &c.) We are only able to give a woodcut; and it is a melancholy pleasure to introduce a description in this work from his pen.

"BARRANDIA (HOMALOPTÉON) LONGIFRONS, Edgell. Woodcut, fig. 42.

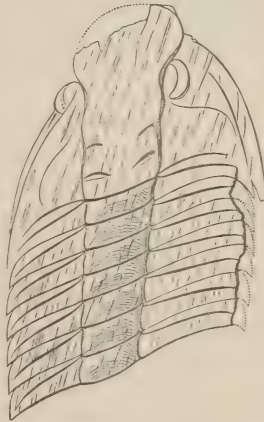
"*B. (Homalop.) magna*, 4 uncias ferè longa; cui glabella producta claviformis, oculi propinqui (sulcus cervicalis abest?). In thorace axis latitudo dimidium latitudinis pleurarum, quarum sulci pæne aciem attingunt, efficit. Cauda semiovata axem conicum gerit, dimidium longitudinis illius efficientem; latus quodque sulco unico furcato distinctum.

"A very large species, with a projecting club-shaped glabella; the axis of the thorax about half the width of the pleuræ; and the tail semicircular or rather semi-oval, each side bearing one strongly branched furrow only. The long clavate glabella, with undulated sides corresponding to the glabella-furrows, projects about one third of its whole length beyond the anterior margin of the cheeks, which are at their base one third wider than the base of the glabella. The rather large eyes are placed considerably forward and close in to the glabella. The fixed cheek is very broad, and the facial suture curves widely out beneath the eye, so that the free cheek is much narrowed, its outline arched almost in a semicircle; it has a narrow but very distinct margin; it shows, so far as our only specimen can be trusted, no neck-furrow (the front thorax-ring has been pushed under the head and appeared to us at first sight as a branched neck-furrow), the cheek ends posteriorly in a small needle-shaped head-spine.

"There are, apparently, seven thorax-rings, as in some other species of this genus. The pleural furrow is well defined, and reaches almost to the tip of each of the recurved flat pleuræ.

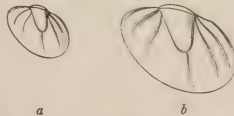
"The tail, fig. 43 (natural size and enlarged), found in the same locality, is supposed to belong to this species, as only one other *Barrandia* (*B. Cordai*, M'Coy, a small species) is known to occur there. The length of this caudal portion is almost equal to its breadth; the axis is conical, the base being about half the length. The side has two furrows, or perhaps a strongly branched one (the branch arising as usual from the very base, and indicating the suture of the first tail-segment): these nearly reach the outer margin; but no corresponding furrows occur on the smooth conical axis, which is half the length of the whole tail, and ends apparently in a sharp tip, from

FIG. 42.



Barrandia (Homalopteon) longifrons, Edgell.
Llandeilo Slates, Pembrokeshire. Mr. H.
Wyatt-Edgell's Cabinet.

FIG. 43.



a
b
Tail of *B. (Homal.) longifrons*? Llandeilo
Slates, Pembrokeshire. From the same
Cabinet. a, Natural size; b, enlarged.

whence a raised line runs to the margin, a common circumstance where the axis is abbreviated.

"Length of head and thorax taken together three inches; length of the supposed tail (of a younger individual) five lines.

"*Locality*.—LLANDEILO SLATES of Aberiddy Bay, Pembrokeshire; in my collection."
—H. Wyatt-Edgell.

We may now proceed with the most abnormal of all the *Asaphidæ*—the group of *Illænus*, so very characteristic of Lower Silurian—the "*Faune Seconde*" of Barrande. It is true that in one of its subgenera it rises into the Upper Silurian; but the mass of the species, and especially the abundance of individuals of this genus, mark Llandeilo and Caradoc rocks (Lower and Middle Bala of Sedgwick) most effectually. [Lower, Middle, and Upper Bala rocks of Sedgwick are equivalent to Llandeilo, Caradoc, and Llandovery.]

ILLÆNUS, Dalman, 1826.

Of all the higher Trilobites, this is the most abnormal in shape;—the segments of the large head, and of the equally bulky tail, being so condensed and obliterated as to leave those portions like the rudimentary extremities of an *Agnostus*; while the structure of the pleuræ, the form of the head, eyes, labrum, and rostral shield,—the thick sculptured crust, and the perfect mobility of the thorax-rings, all mark the genus as one of high rank among the *Asaphidæ*, and as nearly allied to the *Proetidæ*, the highest of the smooth-eyed groups.

All the species of the genus have a common facies:—the similar head and tail, unmarked by lobes or annulations; the glabella, cheeks, and margin being usually confounded in one hemispheric mass; and the axis, in most instances, scarcely indicated outside the caudal shield. The creature could roll itself up into a perfect ball, and, no doubt, chiefly suggested to Dr. McLeay the analogy with *Bopyrus* and other *Isopoda*; the resemblance to the Armadillo Woodlice is not less striking. Yet the *Isopoda* have crustaceous feet well articulated, and we have yet to learn that Trilobites had any crustaceous feet at all.¹

¹ I find that every one in our own country has overlooked a very important notice, by Dr. Volborth of St. Petersburg ('Verhandl. Min. Gesellsch. Petersburg,' 1857-8, p. 168), of the discovery, by Dr. Pander, of some appendages, which may be membranous feet, attached to definite parts of the outer portion of the pleuræ beneath. I do not know that Dr. Pander has published this in any definite form, but Dr. Volborth has fully described and figured these points of supposed attachment for swimming feet ('Mém. Acad. Imp. Petersb.,' 1863, tom. vi, No. 2). Barrande observed them in 1855, in *Ogygia*, and described them in 1858. Mr. E. Billings, Palæontologist to the Canadian Survey, has also found in *Asaphus gigas* a trace or two of curious processes below the crust, but close to the axis. All these data have great value; and those who have abundance of specimens of *Asaphus expansus*, from the fine Lower Silurian mudstone of St. Petersburg, will do well to cut and polish specimens, observing all traces of fragments of the general lower membrane, as well as of distinct processes (for details see 'Mém. Acad. Imp. Petersb.,' 1863).

Illænus is as compact a genus as any in the whole Trilobite Order. It comprehends almost as many distinct, if less varied groups, as *Phacops* itself; and all of these have the common facies of an inflated head and caudal shield, without external lobes or rings, and that peculiar hemispheric contour to each, which is so marked a character of the whole genus. Sometimes, the angles of the head are shortly spinous (*Dysplanus*), but usually they are rounded off and unarmed (*Illænus*, *Bumastus*); sometimes the eye is subcentral (*Il. centrotus*), but more commonly it is placed behind the middle of the head, and near the posterior margin (*Il. crassicauda*, *Il. Bowmanni*, &c.). A few have the axial furrows reaching quite up the head (*Il. distinctus*, Barr.), but in the great majority they reach less than two-thirds this distance—and are often less than half-way. In a very few the eyes are large (*Il. ocularis*), but usually they are small. The labrum varies in shape in the different subgenera (see figs. 44 *a*, *b*).

Lastly, the number of body-rings varies.¹ Two sections, perhaps distinct genera, *Panderia* and *Octillænus*, have but 8 rings. *Dysplanus*, including species with both spinous and rounded head-angles, has only 9 rings. *Illænus* proper has 10 body-rings, and this includes many well-known species; while *Bumastus*, Murchison, which, like *Illænus*, has 10 rings, has the axis very wide, and so little distinguished from the pleuræ as to give a unique aspect to the fossil.

I agree with Barrande,¹ that it is wiser, in the present state of our knowledge, to include all these subgenera under one common name; dividing them into groups, which may, by and bye, if the characters prove constant, be called genera. All of them appear to agree in the following characters:

Head hemispherical, or rather quarter-spherical, with rounded contour, no marginal furrows, and a very slight indication of neck-furrow. Glabella lobeless externally; within it has often 4 pairs of lobes, and is separated by incomplete axial furrows from the tumid cheeks. Eyes lateral, remote. Epistome striate, with a well-defined transverse rostral shield, and bearing a somewhat triangular tumid labrum, which has a strong border and expanded base (see fig. 44 and Pl. XXVII, fig. 7).

Body-segments 8—10; usually 10, without grooves to the pleuræ. Tail large, hemispheric, with a short incomplete axis, showing numerous rings, but only within the crust.

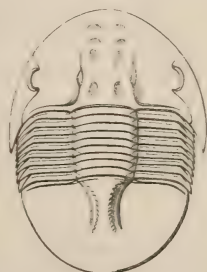
The genus, world-wide in its distribution, is neatly distinguished from all others by habit, as well as a combination of characters. These are

FIG. 44.



a. Labrum of *Illænus centrotus* (after Volborth).
b. Labrum of *Illænus crassicauda* (ib.).

FIG. 45.



General type of *Illænus*.
Il. centrotus, Dalm. North Russia.
 (After Volborth).

¹ Barrande has enumerated 11 genera in which the number of rings is variable.

maintained, though under considerable variations, throughout the North and Central European types and those of Canada and North America. The greatest variation is found among the oldest forms, viz., those from the Arenig and Llandeilo rocks, where the genus first appeared. If we look to our plates, we shall find that the ordinary species of *Illænus* have the furrows which mark out the glabella very short externally, and the eye placed at a moderate distance or somewhat remotely from the glabella, and behind the middle of the cheek. But in the oldest group of Silurian rocks known to contain *Illænus*, the eyes are placed so far forward and outward, that in one form, *Ectillænus* (Pl. XXVI, fig. 8), they seem at first to be absent altogether; and in *Hydrolænus*, a Canadian subgenus (*Illænus conifrons*, Billings), the glabella-furrows are so long as to reach the front, the glabella so gibbous as to overhang it, and the eyes are extremely forward. These two subgenera lead directly to *Illænopsis* (Pl. XX, fig. 1), which is from the Arenig rocks (it has been quoted from May Hill Sandstone!).

If we divide *Illænus* into the undermentioned sections, following the lead of previous authors, it is not because we think the divisions quite natural, but because they are convenient. Some of the subgenera will be hereafter elevated to generic rank when we know more of the lobes of the head, not often visible even in internal casts.

§ 1.—Trilobed: labrum elongate.

1. *Octillænus*, Salter, 1866. Eight rings; a well-defined glabella, and the upper pair of pleuræ produced. Lower Silurian, Central Europe.

Illænus Hisingeri, Barr.

2. *Panderia*, Volborth, 1863. Eight body-rings; short glabella-furrows, and ordinary ungrooved pleuræ. Lower Silurian, North Europe.

Il. triquetra, Volb.

Il. Lewisii, Salter.

3. *Dysplanus*, Burmeister, 1843. Nine rings; ordinary pleuræ. Lower and Middle Silurian.

Il. centrotus, Dalm.

Il. Boumanni, Salter.

4. *Illænus* proper, Dalman, 1826. Ten body-rings; ordinary pleuræ; eyes subcentral. [The greater number of species belong to this subgenus.] Lower Silurian, universal.

Il. crassicauda, Wahl.

Il. Murchisoni, Salter.

Il. Davisii, Salter.

Il. Rosenbergti, Eichw.

5. *Ectillænus*, Salter, 1866. Ten body-rings; ordinary pleuræ; eyes remote and very forward; glabella-furrows short. Lower Silurian, only British as yet.

Il. perovalis, Murch.

6. *Hydrolænus*, Salter, 1866. Eyes remote, forward; glabella-furrows reaching the front; head most gibbous. Lower Silurian, Canadian.

Il. conifrons, Billings.

7. *Illænopsis*, Salter, 1865. Eyes remote, forward; glabella-furrows reaching the front; head not gibbous, only convex; pleuræ grooved. [Probably a distinct genus.] Lowest Silurian, British.

Il. (Illænopsis) Thomsoni, Salter. [Not *Illænus Thomsoni*.]

§ 2.—Body scarcely trilobed: labrum short.

8. *Bumastus*, Murchison, 1837. Eyes large, remote, backward; ten body-rings. Lower and Middle Silurian, but chiefly Upper; universal.

Il. Barriensis, Murch.
Il. carinatus, Salter.

Il. insignis, Hall.
Il. Trentonensis, Hall.

Subgenus 1.—Of OCTILLÆNUS we have no British types. It is a Lower Silurian Bohemian form. We give a woodcut (fig. 46), as it is so peculiar a form of the group, from Barrande's figure. The enlargement of the first pair of pleuræ is a very unusual character in the *Asaphoid* or smooth Trilobites.

FIG. 46.



Il. (Octil.) Hisingeri, Barr.
Lower Silurian, Bohemia.

Subgenus 2.—PANDERIA, Volborth, 1863.

ILLÆNUS (PANDERIA) LEWISII, n. sp. Pl. XXVI, figs. 2, 2a, b (nat. size and magnified).

Il. (Pand.) minimus (forsan junior?), $\frac{7}{12}$ uncia longus, via $\frac{5}{12}$ latus, ovatus, capite (glabellâ præcipuè) gibbo, thoracem longè superante, et caudâ planatâ bis ferè longiori. Caput subtrigonum, fronte paullo producta, angulis obtusis marginatis. Glabella post verticem gibba, $\frac{3}{4}$ latitudinis capitis efficiens, oculos attingens. Sulci axiales brevissimi, ad basin glabellæ solum conspicui. Oculi magni, glabellam appressi, dimidium diametri suorum a margine distantes. Thorax axe modico, anticè latiori, pleuras subplanas superante. Cauda brevis semiovata planata, axe longo, per totam longitudinem conspicuo.

Had not Dr. Volborth figured two species of this very distinct subgenus, one of which is given on the next page, I should have taken this for the *young* of some undescribed species. The large size of the head and eyes relatively to that of the tail, and the more complete marking out of the axis in the caudal shield, are characters belonging usually to young specimens. But there can be little doubt we have here nearly, if not quite, the adult form of a subgenus not heretofore described from Britain, and apparently rare even in Northern Europe. We owe our single specimen to the care of Mr. Lightbody, who obtained it for this work from the cabinet of the Rev. D. P. Lewis, of Guilsfield, near Welchpool. It is a valuable addition to British fossils.

The width of our single rolled-up specimen at the base of the head is 5 lines, and, the length of the large head being fully 4 lines, we may reckon the whole specimen as 7 or 8 lines long. The form, unrolled, would be ovate, the gibbous head being

somewhat trigonal, with the front a little produced, the sides flattened, and the hinder angles much rounded. The head is very gibbous, a section of it across the eyes, as shown in fig. 2, being a broad parabola. The principal gibbosity lies in this line, about the base of the great eyes. These are closely appressed to the glabella, so as to abut at their lower end on the short axial furrow, which is conspicuous here, but is not carried further up. And the eyes are placed about half their length distant from the posterior margin of the head.

The course of the facial suture, below the eyes, is abruptly outward; above them it runs direct to the front margin, in a line continuous with that of the short axial furrows before noticed. The cheeks are much flattened, and decline rapidly, and our figure 2a rather too strongly expresses a marginal furrow within the angle—a character common enough in other genera, but extremely rare in *Illeus*.

The thorax, of only 8 rings, has a broad axis, which tapers backwards, and is gently convex. The pleuræ are not so wide as the axis; they are flat as far as the fulcrum, which is placed at one half in the hinder rings, and is pretty close to the axis in the front ring; thence they bend a very little downward and backward to the oblique tips.

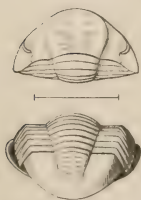
The tail is less than a semioval, and has the front edge straight. The axis is equal in breadth to the sides, and reaches down three fourths the length of the tail; it is rounded at the tip, flattened above, and with a distinct furrow all round it. The tip is very little prominent, but clearly defined by the prominence, as the sides of the axis also are by the axial furrows. The limb is flat, as, indeed, the whole tail is; and only the edge turns gently downward.

The relatives of this little species are clearly to be found in the *Panderia*¹ *triquetra* and *P. minima* described by Dr. Volborth in his paper in the 'Transactions of the Imperial Academy of St. Petersburg,' vol. vi, No. 2, 1863, pl. iii, figs. 13—19. One of these is given in our woodcut, fig. 47. Though I think *Panderia* only a subgenus, it is a very good and distinct one; and the eight body-rings, with their tapering axis, the flattened caudal shield with its long distinct axial lobe, and the large relative size of the head and eyes, mark it as an embryonic form (not using this word in a strict sense) of a comprehensive genus. The figure of *P. minima* is especially like ours in the gibbosity of the vertex, direct facial suture in front, and approximated eyes; and it is about the same size. Still, it differs in nearly all its proportions from *P. Lewisii*.

Locality.—CARADOC OF BALA limestone of Moelydd, Oswestry,—near Llanymynech quarry (where "Fossils" is printed on the Ordnance Map). Cabinet of the Rev. D. P. Lewis).

¹ Named in honour of the veteran naturalist Dr. Pander, so well known for his works on the fossils of Russia. See foot-note, p. 180, for a reference to his discovery of the membranous feet of Trilobites.

FIG. 47.



III. (*Panderia*) *triquetrus*, Volb.
L. Silurian, N. Russia.

Subgenus 3.—DYSPLANUS, Burmeister, 1843.

ILLÆNUS (DYSPLANUS) BOWMANNI, *Salter*. Pl. XXVIII, figs. 6—13; Pl. XXX, fig. 6.

ILLÆNUS CENTROTUS, *Portlock*. Geol. Rep., pl. x, figs. 3—6 (not fig. 9), 1843.

IL. BOWMANNI, *Salter*. Mem. Geol. Surv., vol. ii, pt. 1, pl. viii, figs. 1—3, 1848; Decade 2, art. 2, p. 3, 1849; in *Morris's Catalogue*, 2nd ed., p. 110; Appendix A to the *Woodwardian Synopsis* p. 4, 1852. *Siluria*, 2nd ed., passim, 1859; also Mem. Geol. Surv., vol. iii, p. 317, pl. xviii, fig. 8, 1866; and *Catalogue Mus. Pract. Geol.*, pp. 5, 19, 1865.

IL. CENTROTUS, *M'Coy*. Synopsis Sil. Foss. Ireland, p. 54, 1846; *Dysplanus*, Synopsis Woodw. Fossils, pl. i E, fig. 19, 1852.

IL. LATUS, id. Ibid., fig. 17.

II. (D.) 3-4 uncias longus, convexus, lævis nisi cauda lineis nonnullis Λ-formibus ornatâ; capite valde convexo caudam obtusam longitudine superante, thorace brevi. Caput semiovatum, convexissimum, sulcis axialibus brevibus, superne recurvis sæpè claviformibus, per tertias longitudinis capitis extensis. Genæ parvæ declives. Oculi minimi, distantes, basi capitis proximè. Anguli obtusi, nec spicula gerentes. Thoracis longitudo dimidium capitis totius efficit, annulis 9; axis ejus convexus, et pleuris antè latior est; at posticè, in pullis præcipuè, angustior. Pleuræ fulcro tenus planæ, dein recurvæ paulloque decurvæ. Fulcra anticè in tertias, postice in dimidium latitudinis pleurarum posita. Cauda lentè convexa, semiovata, obtusa: cujus longitudo $\frac{2}{3}$ latitudinis suæ efficit; are magno superne tantum inter foveas latas conspicuo, sulcis obscuris. Lateralia convexa, sulco superno lato, et interdum (in pullo) sulcis binis obscuris.

A large species, frequently four inches long; oblong, with blunt and very convex extremities: the head not much larger than the tail, the thorax scarcely more than half the length of the head, and but little more compared with the tail; the eyes small and remote; the axis of the thorax wider than the pleuræ.

Head regularly convex, semi-oval; glabella wider than the sides, its furrows slightly converging as they reach one third up the head. Cheeks gently declining to the remote eyes, which are distant from the axial furrows about half the width of the glabella; and thence bend steeply down to the incurved margin. The eye is very short and small, and placed so far backwards as to be only its own length distant from the straight posterior margin. Free cheeks very small and narrow, with blunt rounded angles (not acute and produced as in *II. centrotus*). The facial suture is nearly direct, *i.e.* vertical above and below the eye. The neck-furrow is distinct in casts, but beneath the cheek only; a deep punctum at the base of the axial furrows defines its position under the glabella. The section of the head across the eyes is an arc of a circle about one third of the whole circumference, and from

front to back the curvature is similar, but more abrupt in front, where the forehead overhangs.

Thorax about half the length of the head, and about three-fourths the length of the tail; of 9 rings. The axis gently convex, broader than the lateral lobes, and tapering but little backwards; marked out by strong but not deep axial furrows from the pleuræ. These are flat as far as the fulcrum, which is at one third anteriorly, and at one half posteriorly. From this point the pleuræ are bent gently down and a little backwards; the front ones more so than the hinder ones, which last are nearly direct.

Tail regularly and gently convex, half a broad oval; the length being two thirds the breadth. The upper angles are strongly truncated; the axis, which is more than one third the breadth, being only marked out by broad indentations in the upper part, and having no true axial furrows. The tail-margin is neither obtuse nor recurved, but regularly and evenly declines to the smooth edge. Caudal fascia concave,¹ rather narrow, especially towards the upper angles, broader below, and not indented by the axis internally.

Variations.—In young specimens the glabella is narrower in proportion (Pl. XXVIII, fig. 8; and see also Portlock, Pl. 10). The thorax too is longer in proportion and more quickly tapering behind; the tail is flatter, and so short as to be less than a semicircle (see also fig. 9). Such variations in the young state are common among the species of this genus. Rarely, as in Pl. XXVIII, fig. 11, the glabella-furrows are longer and more connivent, and more recurved above; fig. 6, again, same plate, represents a May Hill Sandstone specimen, in which these furrows are shorter than usual. Some specimens have them straighter than others, and they vary a little in depth.

Ilænus latus, of M'Coy, is, I think, only a compressed specimen. We have several such forms from Pembrokeshire and elsewhere. It is figured in p. 215, woodcut 54.

Our fossil has been referred both by Gen. Portlock and Prof. M'Coy to the Swedish form, *Il. centrotus*. I cannot clearly make out why; for the distinction of rounded (instead of spinose) angles was clearly pointed out by myself, in the Appendix to the Woodwardian Synopsis; and I communicated freely with Prof. M'Coy. I have re-examined the foreign specimens, and am convinced the species are only allied, not identical. The position of the eye at once separates our fossil from *Il. Davisii*; these two hardly ever occur together, *Il. Davisii* requiring, to all appearance, a purer element than the more common *Il. Bowmanni*, which could live on mud, sand, gravel, or any kind of sea-bottom. It, however, seems to have preferred a calcareous sea-bed when it could get it.

Localities.—LLANDEILO FLAG, or *Lower Bala*, rare. Knockdolian, Ayrshire (*Woodw. Mus.*)? Everywhere in CARADOC or BALA Rocks, N. and S. Wales, Westmoreland; S. Scotland; North, East, West, and South Ireland. A few localities may be given: Bala, abundant, especially east of the lake (*I. Davisii*, west and north); Dinas Mowddwy; Llanfyllin; Llanfairynghornwy, Anglesea; N. W. of Llandeilo; Shoal's Hook, &c., in

¹ That is, reflected closely for its anterior half upon the upper crust; most of the species have it convex, i. e., concave upon the cast. Probably the difference is due to greater flexibility in the membranous fold.

Pembrokeshire. In Ireland:—Tyrone; Portrane, Dublin; Chair of Kildare; Wexford; &c. LLANDOVERY Rocks, Girvan, Ayrshire, abundant; Builth; Llandoverly; Haverfordwest (with *Ill. Thomsoni*), and other localities in S. Wales. Kilbride, Co. Galway (Sir R. Griffith). MAY HILL SANDSTONE, Shropshire, rarely, viz.—Norbury, Pl. XXVIII, f. 6; Chirbury. Also in the Purple ('Tarannon') shales of the Onny River, Shropshire (Cabinet of the late H. Wyatt-Edgell, Esq.). Our figures are chiefly from the Museum Pract. Geology. The species never occurs in Wenlock rocks, and but rarely so high as May Hill Sandstone.

Mr. Wyatt-Edgell's cabinet contains a caudal shield, clearly intermediate in form between *Il. Bowmanni* and our next species, which must be regarded therefore as a subspecies only. We shall term it *Il. æmulus*:—

Subspecies I.

ILLÆNUS (DYSPLANUS) ÆMULUS, n. sp. Pl. XXVIII, fig. 5.

Il. (D.) modicus, forsan triuncis, depressus, superficie imbricatâ, caudâ (cætera non adhuc inventa sunt) latâ. Long. caudæ 16 lin., lat. 2 unc. Cauda semicirculata, antè subrecta (angulis truncatis exceptis), posticè æquabiliter rotundata. Axis dimidium caudæ vix efficiens, brevis; sulcis axialibus latis convergentibus, ad marginem superiorem profundis latisque. Annuli in axe antico 5-6, inconspicui, arcuati. Lateralis sulcis 3-4 brevibus et radiantibus distincta, quorum supernum latus profundius. Fulcra ab axe dimidium latitudinis ejus distantia. Anguli truncati, facie externâ curvâ. Margo valdè deflexus. Fascia lata.

A single caudal shield or two only of this remarkably fine fossil have yet occurred. They are from that as yet little known formation, the May Hill Sandstone, and are in the collection of Silurian fossils in Jermyn Street. Collectors should search for the head and body-rings, which probably would indicate a short obtuse species, depressed above, but convex on the borders. It can only at present be regarded as a subspecies of the preceding.

Tail 2 inches wide, and 1 inch 4 lines long; semicircular, convex on the steep sides and depressed above. The anterior border is rather straight. The axis is broad above, defined there by wide axial depressions, and not quite equal in width to half that of the front margin; from thence greatly converging shallow axial furrows reach one third down the tail. The axis is, however, really extended further, and is faintly indicated as far as nearly half-down the tail; it forms nearly an equilateral triangle—our figure does not show this quite correctly. Faint arched rings, five or six in number, ornament the upper part, and seem to run almost continuously into the strong squamate Λ -shaped plicæ which ornament the surface. These are stronger, sharper, and more remote than in any species with which I am familiar.

The sides show a remote fulcrum, placed at about half the width of the axis away from it, and thence a suddenly recurved facet, which is convex outwards, while

in most species it is nearly flat. The angles are thus truncated considerably; and this gives this rare species much the look of the ordinary *Il. Bowmanni*, figured in the same Plate, fig. 7.

The sides are moreover radiated by 4 short furrows; of which, as usual, the uppermost, subtending the fulcrum, is broad and strong; the second fainter, and the rest obscure. These furrows do not reach above half across the sides, which are gently convex only above, and then slightly decurved. Our figured specimen is a perfect internal cast in arenaceous limestone, and therefore, not being broken, conceals the fascia entirely. But a Presteign specimen, in the 'Mus. P. Geology,' shows a broadish *fascia* with remote *striæ*.

The ornament of the surface is very remarkable, as above noticed. Strong, arched, or rather bent *striæ*, which run up obliquely from the sides towards the axis, inosculating as they go in rather an unusual manner. They keep clear of the deflexed margin, and do not cover the upper half of the sides, but reach the lower half of the short axis, and seem to be continuous with its obscure arched furrows, indicating the many axial rings. Where they meet from either side they take a Λ -shaped form, something like the ornament on *Lucina divaricata* and many species of *Pecten*.

Localities.—MAY HILL SANDSTONE of Upper Snead, near Chirbury, Shropshire. Also Presteign, Radnorshire. (Coll. by Mr. J. E. Davis: both specimens are in the Mus. Pract. Geol.)

ILLÆNUS (DYSPLANUS) THOMSONI, *Salter*. Pl. XXVIII, figs. 2—4; Pl. XXX, figs. 8—10.

ILLÆNUS (DYSPL.) THOMSONI, *Salter*. Quart. Geol. Journ., vol. vii, p. 171, pl. ix, fig. 3, 1851.

— — — *Id.* Siluria, 3rd ed., Appendix, 1867.

— — — *Id.* Mem. Geol. Surv., vol. iii, p. 360, as *Illænopsis*, in p. 231, 1866.

Il. (D.) maximus, 6 uncias longus, $3\frac{1}{4}$ latus, lævis; capite lentè convexo, caudam semi-ellipticam vix superante, thoracem valde trilobum hac superante. Oculi modici, haud distantes, longitudinem eorum à margine postico distantes. Anguli rotundati? Genæ parvæ. Thoracis longitudo $\frac{2}{3}$ capitis efficit, annulis 9;¹ axis ejus valde convexus pleuris latior est. Pleuræ fulcro tenuis (hòc postice ad dimidium posito) planæ, dein abruptè declives et reflectæ. Cauda lentè convexa, axe magno tantum inter foveas conspicuo, sulcis omnino obsoletis. Latera abruptè latèque truncata. Fascia latissima concava, striis raris conspicuis.

There is a close general resemblance in this bulky Llandovery species to the more common *Il. Bowmanni*. I have therefore contrasted the diagnoses minutely, and beg the

¹ I think I am not mistaken in this number. We have two perfect specimens, but in both the rings have somewhat slipped over each other. The relation of the species to *Il. Bowmanni* is so close in many respects, that it can hardly be other than a *Dysplanus*.

patience of classical readers for their unwieldy length. *Il. Bowmanni* has the greater range, for our fossil is confined to the Llandovery and May Hill rocks; but in the former the two species frequently occur together, and their differences then become manifest enough. The larger form has much less remote and less backward eyes, a stronger trilobation, and a more tapering shape in the axis of the thorax; the pleuræ are more abruptly bent backward; and the tail longer in proportion to the width.

It needs close examination to detect these proportional differences in the *Illæni*; but the habit and aspect would be alone sufficient, for *Il. Thomsoni* is very much less convex, the thorax much longer, &c. These differences will appear more fully in the course of description.

A large oblong species, not less than six inches by three inches and a quarter! Rounded, but not obtuse, at either end; regularly convex, not at all gibbous; and with the thorax strongly trilobed, the semioval head faintly so, and the tail scarcely at all trilobate. The head appears to be scarcely at all longer than the tail, but both are longer by one third than the thorax. The fine specimen in Pl. XXX, figured from Prof. Wyville Thomson's Cabinet, shows these proportions.

Head only gently convex, and divided pretty equally into glabella and cheeks by long straight axial furrows, faint on the outside, but strong in the cast, with a pair of ovate-lanceolate glands.¹ The cheeks outside the facial suture are narrow and abruptly depressed, but are level from the glabella to the eyes, the latter being large and prominent, and placed at about two thirds the glabella's width away from it; they are fully their own length from the hinder margin, and being larger than in *Il. Bowmanni*, of course appear further forwards than in that species. The sculpture of the head, so far as seen, consists only of short broken arched lines and a few puncta, except over the front, where larger and more remote lines occur at rare intervals. We do not know the actual front margin.

Thorax of nine broad rings, greatly arched forwards on the axis, which even posteriorly is wider than the pleuræ, and greatly so in front; it is divided from these by strong axial furrows. The pleuræ rise a little as they leave the axis, and are gently convex rather than flat² towards the fulcrum, placed at less than half out in the hinder rings, and at one third in front. Thence they bend strongly downward and backward, and are a good deal thickened, as shown in the cast (Pl. XXVIII, fig. 2). The tips are blunt-pointed, not at all truncate as in fig. 7 (*Il. Bowmanni*).

Tail long, semioval, except for the strong re-entering curves and angles of the

¹ I can only suppose these oval spaces, frequently punctate-granulate, to represent one pair of the curious gland-like markings which occur on so many segments of the head, body, and caudal axis in various genera (p. 50, &c.). Prof. W. Thomson does not believe them glands; what are they?

² *Illænus* has apparently ungrooved pleuræ in all the species. These specimens show the meaning of this; for the true position of the groove, which, distinct or not, exists in all Trilobites, is here quite at the hinder edge of the pleura, and is visible internally in the two front rings.

front edge. It is as broad as long, slightly and very evenly convex all over, the broad axial lobe being marked out in front by shallow depressions only, but no trace of axial furrows, however short. The sides, too, show scarce a trace of the usual strong upper groove—so conspicuous in most species. The greatest convexity is about the middle of the caudal shield, and the edge is neither obtuse nor recurved. The front margin of the tail is unusually sinuous. The front edge of the axis is greatly arched forwards; the fulcral point rectangular, and the outer angles widely truncate, so that from the fulcrum the edge is almost vertically cut off. The *fascia*, narrow and convex at the outer angles, becomes very wide and quite *concave* (*i. e. convex* in the cast) round the posterior border, and is coarsely striate.

Localities.—LLANDOVERY ROCKS. Abundant in the light-coloured sandstones of Mullock, Girvan Water, Ayrshire (Mus. Pract. Geology and of Prof. Wyville Thomson). Also the species is common at Haverfordwest, Pembrokeshire (Museum of the late H. Wyatt-Edgell, and of Mr. Lightbody). MAY HILL SANDSTONE, Presteign: Builth: and Pen-y-lan, Llandovery; S. Wales. TARANNON SHALE: Onny River, Shropshire (Mus. Pract. Geol.).

Subspecies II.

ILLENUS NEXILIS. Pl. XXX, figs. 4, 5.

This fossil appears to be intermediate between the ordinary *II. Bowmanni* and our next species *II. Thomsoni*, which is evidently distinct. I cannot be so sure about the present one, which, while intermediate in form, possesses some characters not common to either species. It has the aspect of *II. Thomsoni*, the even contour of tail, and arched convex axis of the thorax, but not the abruptly reflexed pleuræ or long truncate angles to the tail of that species. The position of the eye and the convexity of the head are like those of *II. Bowmanni*; but it differs from that species—by having no trace of the narrow neck-furrow so conspicuous in the Caradoc fossil; and by having a *thickened* line of apophyses below the axial furrows of the longer thorax, which thickened ridge produces a broad and very definite axial furrow in the cast; this is absent in *III. Bowmanni*. Again, the tail is longer; the front margin of its axial portion arched, not truncate; the upper lateral furrows all but obsolete; the fulcrum closer in; and the facet much more oblique, thus truncating the angle very slightly. And the *fascia*, which first drew my attention to this marked subspecies, differs entirely from that of *II. Bowmanni*, and is not quite like *II. Thomsoni*. I have only seen three specimens, all from the same locality, one of which is a caudal shield, showing the considerable size of the species.

Elliptical, 4 inches long, of which the large semioval tail forms nearly one half, while the very convex (not gibbous) head is about one third longer than the strongly trilobed thorax of nine rings.

The head forms a regular quarter of a sphere, and is very equally and highly convex; it is marked for one third up by axial furrows, which first converge a little, and then turn outward above the oval gland. Eye distant from the glabella about half the width of the latter, of moderate size, and placed at less than its own length apart from the neck margin. Cheeks broad, with rounded angles—the facial line divergent above the eye. No neck-furrow, even in the cast.

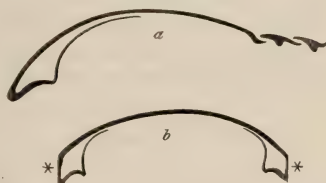
Thorax with its axis nearly parallel-sided, a good deal wider than the pleuræ, and very convex, separated (in the cast, at least) by a broad, flat-bottomed furrow; the pleuræ convex thence as far as the fulcrum, which is placed at one third out in all the rings; the pleuræ bent down and a good deal backwards from the fulcral point; the ends pointed, and curved backward (they are straight in *Il. Bowmanni*).

The tail a long half-oval, broader than long, and not obtuse at the tip; the front margin uneven, divided into a broad axial lobe much arched forward, which is distinctly marked out by axial pits, but no axial furrows. Thence to the fulcrum the margin is straight, and beyond it a wide oblique truncation, with the edge of the facet vertical. No axial furrows or depressions interrupt the smooth contour, except at the extreme front margin.

Our figured specimen shows (the cast being broken) a very broad and remarkably bent fascia beneath, extending near half-way up the tail, and divided into two very distinct portions. The outer part is narrower and only slightly concave round the hinder margin (Fig. 48 *a*); but at the upper angles (in Fig. 48 *b*) this part becomes first flat, and then strongly concave; and thence bends upwards, with a sharp angle (making a deep furrow on the cast) between it and the inner half of the fascia. This *inner* portion is then reflected closely beneath the upper surface, and follows it. The squamous lines which cover the inner half are wide apart; those on the marginal portion closer together. Round the extreme edge the fascia forms a convex fillet, so that the section of the whole fascia, very perfect in this specimen, would be somewhat like our figure 48. The variations of the caudal fascia deserve close study; but the details of its shape are better understood by a figure than description; a circumstance not at all uncommon in natural-history illustration.

Locality.—LLANDOVERY schists of Mullock, Girvan, Ayrshire (Prof. Thomson's and Mr. Wyatt-Edgell's cabinets).

FIG. 48.



Section of the tail, with its incurved fascia: *a*, longitudinal section; *b*, transverse section across the facets (**).

Subgenus 4.—*ILLÆNUS* proper.*ILLÆNUS* (IL.) BAILLY, n. sp. Pl. XXVIII, fig. 14.Compare with *ILLÆNUS CRASSICAUDA*, *Wahlenberg*. Nova Acta Reg. Soc. Sci. Upsal., vol. viii, p. 27, tab. ii, figs. 5, 6, 1821—not of Portlock nor M'Coy.— also with *ILLÆNUS DALMANI*, *Volborth*. Mém. Acad. Imp. Sc. Petersb., vol. vi, No. 2, p. 13, tab. ii, figs. 7—13. *Il. crassicauda*, Dalm. et Auctorum, fide Volborth, 1863.

Ill. (Il.) magnus, 4 uncias longus, $2\frac{3}{4}$ latus, ellipticus, obtusissimus, profundè trilobus; caput gibbum multùm caudà planiore majus, oculis distantibus retrorsis; angulisque rotundatis; thorax caudà brevior. Caput transversum valdè convexum, vix gibbum, glabellà angustà, sulcis axialibus brevibus tertias capituli efficientibus. Genæ abruptè declives. Oculi modici eminentes, longè à glabellà positi, et dimidium longitudinis eorum a margine postico distantes. Axis corporis convexus, parallelus, pleuris vix latior: his fulcro tenus (ad dimidium posito) planis, dein valdè deflexis, paullo (posticis præcipuè) recurvis. Cauda semicirculata (angulis obliquè truncatis), subplana seu lentè convexa, aë lato, inter foveas latas tantùm conspicuo, sulcis axialibus nullis: margo acutus, nec recurvus.

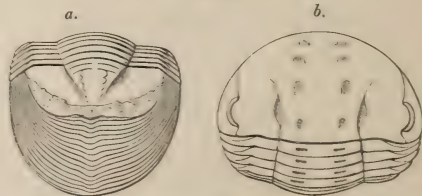
I have purposely confined the diagnosis and description to our single British specimen. It may, indeed, possibly prove identical with the common Scandinavian form above quoted. But it is much larger than *Il. crassicauda*, at least if the specimens which reach England are fair samples of that species. (I have here figured *Il. crassicauda* and its ally *Il. Dalmani*, for comparison.) And while in the position and size of the

FIG. 49.



Internal cast of *Illænus crassicauda*, Wahl. showing alimentary canal (full of ingested matter?), from Volborth.¹

FIG. 50.



Illænus Dalmani, Volb. (After Volborth). Lower Silurian, North Russia.
a. The caudal fascia, seen when the surface of the cast is broken away.
b. Interior of cast, showing lobes (attachments of muscles?).

¹ Volborth "On the Smooth-tailed Russian Trilobites," 'Mém. Imp. Acad. Sc. Petersburg,' 7th ser., tom. vi, No. 2, 1863. From this important and philosophical memoir our woodcuts illustrative of the structure are all taken. Dr. Volborth discusses all the accessible points of the anatomy of *Illænus*. He regards the internal tube (fig. 49) as the dorsal heart, comparing it with that of *Apus canceriformis*. I trust I am not presumptuous in supposing that the viscus represented by Dr. Volborth as a heart or

eye, the convexity of the head between the eyes, and the proportionally longer tail-piece, our fossil differs from the ordinary *Il. crassicauda*. A nearer approach is made in these respects to Dr. Volborth's new variety or species *Il. (crass.) Dalmani*, Volb. ; but I will not unite it with that form, which has larger eyes, nearer the glabella—a longer head, and squarer head-angles. The species is so near to these two Russian forms, that I give a woodcut of both, more especially for the purpose of showing the structural points gained for us by the acumen of Dr. Volborth, in the work cited in the foot-note.

We have but one specimen, rolled up, of this fine species, for the use of which I am indebted to the Irish Geol. Survey. At first sight it was naturally taken for *Il. Bowmanni*, the common Lower Silurian form ; and it occurs in beds of the same age. To that species, too, it bears much resemblance in the shape of the head, position of the eyes, and the general aspect.

But it is a true *Illænus*, with 10 rings—not a *Dysplanus* ; and its alliance is with the Swedish forms of *Il. crassicauda*, Wahl., and *Il. Dalmani* of Volborth. *Il. crassicauda* has been often quoted from Britain, but *always erroneously* ; whether this may be an extreme variety of that northern species, uniting the above-mentioned forms, I am not quite sure ; but I shall try to point out its proportional differences, which are nearly all the characters we have to rely on ; at least, in the great majority of the species of this very uniform genus.

Our coiled-up specimen, with the crust preserved, measures rather more than three inches in breadth, and when uncoiled must have been four inches long. Of this length the large semicircular head, more than a quarter of a sphere in convexity,¹ is two and three quarter inches long, obtuse in form, but regularly convex, and three inches broad. The glabella occupies less than a third of this breadth, and is defined only by short axial furrows, strongest behind, which do not reach one third up the head. The prominent eye is placed as far from the glabella as the width of the latter, and very close to the hinder margin—not its own length from it. The facial suture beneath it turns sharply outward. In front of the eye its course is not known. The cheeks slope gradually down, not abruptly, and are greatly rounded off at the angles—more so than in kindred species. The chief convexity of the head is more than midway up—not near the vertex as in *Il. crassicauda*, which, seen from above, has a shorter head and less rounded angles (Volborth, l. c., pl. ii).

The thorax is much shorter than the head, and rather shorter than the tail, the proportions of the three being nearly as 4 : 2½ : 3. This may probably vary in some individuals, and is sure to be different in younger specimens, which would have the tail shorter.

dorsal vessel (see woodcut 49) must be the cast of an annulated or saccate intestine. It seems to me all but impossible that the contents of the heart should be preserved in a solid state ; but the *ingesta* may easily be so, if I am right in supposing the food to be silty matter.

¹ A precise English term conveying this idea—parallel to the terms spherical, hemispherical—is wanted. Will any Greek scholar supply it? *Tetartospherical* is a long word to use, and I hate *verba sesquipedalia* ; still, we require a term for a shape very common in the carapaces of Crustacea.

The axis of the thorax is regularly convex ; it is divided from the pleuræ, which are narrower by one fourth than the axis, by straight and parallel furrows, sharp but not deep, and continued a very little way into the tail. The fulcral points are placed rather more than one third out, and at nearly equal distance in all the rings ; and the pleuræ are thence curved, rather than bent downward, and turn but little backward except in the front rings. The tips seem to be squarish or obtuse, and are not recurved.

Tail semicircular, not much sinuated on the front border, the broad axis being scarcely arched forward ; and the facet beyond the fulcrum, following the line of the pleuræ, forms a very obtuse angle with the straight portion (not abruptly cutting off the angle, as in many species,—*Il. Thomsoni*, for instance). The general convexity is slight and very regular, the border not being abruptly decurved ; and the axis is obscure, except for the broad obtuse depressions on the front border ; it does not form any axal lobe.

Comparing this form with the typical *Il. crassicauda*, as given by Volborth, we find the head less gibbous, and more generally convex ; the eyes smaller, and placed further out ; the fulcræ of the pleuræ at nearly equal distance from the axis in all the rings ; and the tail proportionately longer, with the axis indistinct, except quite in front.

Some of these differences become resemblances when we compare this form with *Il. Dalmani*, which Volborth has critically distinguished. But the head of that species is less convex than ours, and longer too—semi-elliptical rather than semicircular. The transverse section of a rolled specimen of that species is more obtuse than in ours, and less pointed at the ends. The cheeks bend more steeply down. The tail is longer than in the British specimens, and has the axis well marked out, &c.

I cannot think, therefore, I shall be wrong in distinguishing our fossil by the name of W. H. Baily, Esq., whose useful work as Palæontologist to the Irish Survey deserves full recognition. Mr. Baily has sent me several undescribed forms, which will be referred to under their proper genera.

Locality.—CARADOC or BALA. Dunabratton Head, Waterford. (Mus. Irish Geol. Survey, Dublin.)

ILLENUS (ILL.) DAVISII, *Salter*. Pl. XXIX, figs. 10—16.

ILLENUS CRASSICAUDA, *Sharpe*. Quart. Geol. Journ., vol. iv, p. 149, 1848.

— DAVISII, *Salter*. Decades Geol. Survey, No. 2, pl. ii, 1849.

— — M'Coy. Synopsis Woodw. Fossils, p. 171, pl. i c, fig. 36, 1852.

— — *Salter*. Ibid., Appendix, p. iv, 1852.

— — *Id.* Morris's Catal., 2nd edit., p. 110, 1854.

— — *Id.* Siluria, 1st edit., woodcut 29, fig. 2, 1854 ; 2nd edit., p. 223, Foss. 44, fig. 2, 1859.

— — *Id.* Catalogue Mus. Geol. Survey, pp. 5, 19, 1865.

— — *Id.* Memoirs Geol. Surv., vol. iii, pl. xviii, fig. 9, p. 317, 1865.

Il. (Il.) minor, $2\frac{1}{2}$ uncias longus, ellipticus, obtusus, convexus, benè trilobus; capite et pygidio ejusdem magnitudinis ferè, oculis parvis approximatis. Caput semiovatum, convexum nec gibbum, glabellâ angustâ sulcis axialibus brevibus convergentibus. Genæ declives, angulis quadratis. Oculi parvi, elongati, glabellâ propinqui, à basi capitis diametrum eorum distantes. Thorax minùs convexus, fusiformis, sulcis axialibus minimè profundis. Pleuræ fulcro axi propinquæ, rectæ, angustæ. Cauda semicircularata ferè, margine antico vix sinuato, angulis vix truncatis; axe lato, inter sulcos latos (in pullo conspicuos) paululum elevato; margine deflexo. Fascia lata, striis crebris.

One of the many peculiar fossils which abound in the more argillaceous parts of the Bala Limestone, but which give place to others directly the matrix becomes sandy. A list of such species is given in the third volume of the Memoirs of the Survey, quoted above.¹ This difference led Prof. Sedgwick and myself, in 1844, to believe there were two bands of limestone; but the researches of the Geological Survey have shown that there is but one principal band. Indeed, the calcareous bed called the Bala Limestone is continuous, or at least intermittent, over something like 4000 square miles. From Kildare, in Ireland, to the Grug limestone² at Llandeilo, in South Wales, in one direction; thence to Bala, in North Wales; at Horderly, in Shropshire; as the Coniston band in Westmoreland; in Ayr, Peebles, and probably through all the Western Highlands, this remarkable band of limestone ranges, and keeps the same fossils throughout, with mere local variations, such as I have just noticed: and, perhaps, there is no species of Trilobite so characteristic of this band (it is not the most abundant) as *Illænus Davisii*. *Il. Bowmanni* nearly everywhere accompanies it, but that species has a wider range, and seems to have been necessarily less confined to one kind of sea-bottom. The reader will pardon this digression for the sake of the facts; the Bala Limestone being the key to the geology of the Lower Silurian (Middle Bala group, Sedgwick).

Il. Davisii is a small species, seldom more than two or two and a half inches long, convex, but not gibbous, well trilobed, but not with deep axial furrows, and with the margin rather suddenly bent down. The eyes are forward and approximate, as com-

¹ I may, perhaps, not have so good an opportunity of showing this change which takes place in one and the same bed of limestone, at a distance of certainly not two miles. Where the Bala Limestone has a muddy matrix the Trilobites are as in the first column: where it is sandy, the other group is conspicuous.

Argillaceous Bala Limestone.

Trinucleus seticornis.

Illænus Davisii.

Cheirurus bimucronatus.

Asaphus radiatus.

Agnostus trinodus.

Ampyx tumidus.

Arenaceous Bala Limestone.

Trinucleus concentricus.

Illænus Bowmanni.

Phacops apiculatus.

Asaphus Powisii.

Calymene senaria

(*Beyrichia complicata*).

The shells follow the same rule, but less strictly.—J. W. S., 1853; 'Mem. Geol. Surv.', vol. iii, p. 273.

² This Grug limestone is often confounded with the Llandeilo limestone: it is brought close to it by faults, but has quite different fossils.

pared with *Il. Bowmanni* and its allies; but this is a true *Illænus*, and does not need comparison with that species. I give the description, revised, from 'Decade 2.'

General form oval; length to width, as 17 : 10; the semioval head and semicircular tail nearly equal in length; the thorax about two thirds the length of either, and strongly, but not deeply, trilobate. The axial furrows are carried less than half way up the head, and but a little way down the tail (except in young specimens, fig. 16).

Head more depressed than a quarter of a sphere, and regularly convex, not gibbous behind (our fig. 13 is too much depressed, being crushed a little). It is divided into three nearly equal parts by the short and slightly converging axial furrows, which turn out again, and then cease at about the level of the top of the eye. The latter is of moderate size, gently lunate and narrow, bounded beneath by a slight furrow, and placed fully its own length from the posterior margin, which shows no trace of a neck-furrow, within or without the crust. The facial suture is divergent above the eye, and slightly so below it, so as to cut the margin beneath the most prominent curve of that organ. The rostral shield (fig. 14) is shuttle-shaped, more than twice as wide as long, and produced into an angle below, where the labrum, which we do not yet know, would fit to it.

Thorax of ten narrow segments, the axis well marked, gently convex, and subfusiform; wider than the pleuræ in the forward segments, in the last only equal to them. The fulcrum is very near the axis in the first segment, and in the last placed scarcely more than a third along the pleuræ, which have a distinct facet and oblique ends. The front pleuræ bend down and a little back; the hinder ones are straight, only bent downward.

Tail semicircular and moderately convex, chiefly so toward the margin, which descends abruptly, but rather flattened along the anterior two thirds. The axis is indistinctly marked out by two deep impressions, which sometimes form short, rapidly converging furrows; the upper corners are bent sharply down beyond the fulcrum, in order to pass freely under the thorax-rings in rolling, but are not truncated as in many species; so that the outline of the tail is tolerably semicircular, and straighter in front than in many forms of the genus. The fascia is of even width all round, and not very broad; it is rather finely striate. The tail, too, has oblique ornamental lines round the margin.

In the tail of young specimens the axis is marked out nearly all round (fig. 16), and extends three-fifths down the tail, which is also flatter.

Var. β, Involutus.—'Decade 2, Geol. Survey,' pl. ii, fig. 8.

The axis in some specimens is so much narrower, and the tail-margin so much more incurved, that the specimens possessing these characters might well pass for examples of a new species. The axis is truly very narrow, and the fulcrum more remote, as usual in all such cases. I find the same form in Dr. Wyville Thomson's Cabinet, from the Ayrshire district, and note it under a varietal name, not much doubting that, when we know the perfect form, we shall find this variety a true species, or, at least, one of those constant forms which botanists call *sub-species*,—a very useful term.

Comparing other species of the same sub-genus with ours, we find that *Il. crassicauda* is not only a much more convex form, but has the head rather gibbous behind; the eyes more remote and further back; the tail scarcely longer than the thorax, the latter having the fulcrum more remote in the front rings, and placed halfway out in the hinder ones; the incurved under portion or fascia (for example see fig. 50) far broader and less concave (*i. e.* less reflected), and the surface sculptured by strong sharp lines; these lines are certainly not conspicuous in *Il. Davisii*, though the latter is not quite smooth.

From *Il. Portlockii* its much greater convexity and the approximate eyes readily distinguish it. The semicircular, not long tail, and oblique pleural tips distinguish it from the species we have named *Il. Rosenbergi*. *Il. Murchisoni* does not need comparison; and the position of the eyes will at once separate our neat regularly convex fossil from the *Il. Bailyi*. I hardly know any species that has better characters of habit; and it is rather strange it should ever have been confounded with the Swedish forms.

Localities.—CARADOC or BALA limestone and slate, west and north of Bala Lake, at Rhiwlas chiefly; also Pont-y-Glyn, Diffwys, Corwen, and other intermediate places; Llanwddyn, Montgomeryshire. (Mus. P. Geol. and Woodwardian Mus.)

In Scotland,—the Wrae limestone; and at Biggar, Peeblesshire. (Mus. P. Geol.)

ILLÆNUS PORTLOCKII, Salter. Pl. XXVI, figs. 3, 4.

ILLÆNUS CRASSICAUDA, Portlock.	Geol. Rep. Tyrone, &c., pl. x, figs. 7, 8, 1843.
— PORTLOCKII, Salter.	Decades Geol. Surv., 2, pl. ii, p. 3, 1849.
— — Id.	Siluria, 2nd edit., Appendix, p. 539, 1859.
— — Id.	Morris's Catal., 2nd ed., p. 110, 1854.
— — Id.	Catal. Mus. Pract. Geol., p. 5, 1865.

Il. (Ill.) modicus, $2\frac{1}{2}$ uncias longus, latè ovatus, depressus, thorace caudâque ejusdem longitudinis ferè. Caput convexum (in juniore) glabellâ angustâ, sulcis axalibus brevibus; oculis distantibus posticis. Thoracis axis pleuris longè latior est, his fulcro tenuis planis, dein subitò valdèque reflexis, deflexis fulcro distante. Cauda planata, transversa, oblonga, subquadrata, angulis externis longè truncatis; axe magno trientem cauda efficiente et ultra, sulcis axalibus subparallelis. Fascia lata concava.

A species well figured in Gen. Portlock's very unfortunate plates; but he referred it, apparently without much consideration, to the *Illænus crassicauda* of Dalman, from which it differs in every particular except the number of body-rings, a sub-generic character. It is of a flattened shape, with short wide triangular tail, and with pleuræ more abruptly bent down than in any other species. *Il. Portlockii* is, perhaps, one of the most distinct of the British *Illæni*. It is only yet known in one locality, the famous Caradoc schists of Desertcreat parish, Co. Tyrone; a spot rendered classic by Portlock's excellent work.

The species must have been fully two and a half inches long, by nineteen lines wide ; broad ovate, depressed. The thorax is nearly as long as the tail, which is wide and very short, and has the angles broadly and strongly truncate. Our smaller specimen has only a very imperfect head, which is very convex, probably even gibbous about the base of the distinct glabella ; the axial furrows are broad, short, and rather deep : the eyes remote, placed near the posterior margin, apparently close to it, and so far apart as to be more than half the width of the glabella remote from it. Head-angles (probably) obtuse.

Thorax of ten rings, depressed ; the axis considerably wider than the pleuræ, and strongly, not deeply, divided from them, scarcely tapering backwards, but more so in the young than the adult.

Pleuræ flat as far as the fulcrum, which is placed far outwards, at about halfway out in all the rings ; in the first rings nearly as far outwards as in the hinder ones, a character by no means common. Beyond the fulcrum the pleuræ are abruptly bent downwards, and very much backwards, almost at a right angle to the line of the pleuræ ; indeed, more so than in any British species, except, perhaps, *Il. Thomsoni*.

Tail quadrate transverse, the posterior margin elliptical, the front edge slightly sinuated by the arch of the axis,—and with the angles so abruptly truncated beyond the fulcrum as to give an oblong instead of a semicircular shape to the tail. The axis is broader than one third of the width of the tail, marked out by short and rather strong sub-parallel furrows, which reach one third down the tail and are then lost,—at least upon the upper surface. Beneath the crust the anal extremity of the axis is prominent, and forms a narrow sulcus in the cast (fig. 3). This reaches nearly to the margin, and probably indents the broad concave fascia ; but our specimen is not quite complete enough to show this. The fascia, however, is slightly convex near the margin, as indicated imperfectly in our figure by a shallow furrow ; and extends halfway, or nearly so, up the tail, parallel with the upper surface ; above it ends just outside the fulcral point.

Locality.—CARADOC schists of Desertcreat, Co. Tyrone. (Both specimens in Mus. P. Geology ; they are Portlock's originals.)

ILLÆNUS (ILL. ?) OCULARIS, *Salter*. Pl. XXIX, figs. 7, 8 (9 ?).

ILLÆNUS OCULARIS, <i>Salter</i> .	Decade 2, pl. ii, p. 4, 1849.
— — — <i>Id.</i>	Morris's Catal., 2nd edit., p. 110, 1854.
— — — <i>Id.</i>	Catal. Mus. Pract. Geol., p. 5, 1865.

Il. (Il. ?) minor, vix unciam latus, lentè conveaus ; capite (solum adhuc cognoto) semicirculato, oculis longis. Caput modicè convexum, insuper depressum, margine frontali gibbo. Glabella genis angustior, sulcis axialibus incurvatis, his dimidium ferè capitis efficientibus.

Oculi longi, glabellæ vicini, à cervice vix dimidium diametri eorum distantes. Genæ triangulatæ, angulis productis nec acutis, haud spinosis. Thoracis axis pleuris vix latior, pleuris anticis deflexis. Reliqua absunt.

This pretty species may or may not belong to *Illænus* proper. It is more depressed than other Lower Silurian forms, and the front margin is suddenly incurved. The eyes are long, not broad, and gently curved, and with the lentiferous area convex. They are placed so near to the posterior margin as to be about half their length away from it; but being of considerable size for the genus, they reach about halfway up the head. The eye-lobe is depressed, and there is no furrow under the eye itself. The glabella is less than a third the width of the head; the axial furrows, sigmoid in shape, rise up to the level of the front of the eye, and do not converge so much as our figure makes them. Our enlarged figure 8a is still a little further defective, as representing the eye too forward. Fine, concentric, wavy, continuous lines ornament the whole head, but are most conspicuous and coarse around the inflected front margin.

Only parts of three front body-rings are present. Their axis is a little wider than the recurved pleuræ, which are bent down and backwards from the approximate fulcrum, and appear to have rather an attenuated form and oblique apices. They are longitudinally striate.

It is with some doubt that I add fig. 9 to this species; it has a proportionately still larger eye, and a squarer cheek-angle, not so much produced as in the small form. But these may be characters due to age, and there is no other species to compare either with; so I leave it. It is worth figuring, at all events.

Locality.—CARADOC or BALA Limestone, Chair of Kildare, Kildare; quoted as Llandeilo in the 'Decade,' as the Bala Limestone was formerly not known to be the exact equivalent of the Caradoc, but supposed to be the Llandeilo Limestone, until the fossils disproved it. (MUS. P. GEOLOGY. Only these two specimens are known to me.)

ILLÆNUS ROSENBERGII, *Eichwald*. Pl. XXIX, figs. 2—6.

- ILLÆNUS ROSENBERGII, *Eichwald*, Geogn. Zool. per Ingriam, Tril. Obs., &c., t. iii, fig. 3 (?), 1833.
 — — *Salter*. Mem. Geol. Surv., vol. ii, part 1, p. 338 (not plate), 1849.
 — — *McCoy*. Synopsis Woodw. Mus., p. 172, 1852.
 — MURCHISONI, *Salter*. Id., Appendix, pl. i g, figs. 33—35 (not of Decade 2, Geol. Surv., which is the true *Il. Murchisoni*): see p. 201, 1852.

Il. (Il.) 4—5 uncias longus, gibbus, intus granuloso-striatus, capite valde convexo longitudine caudam rotundatam superante, thorace longo. Caput semiovatum, convexissimum, fronte gibba impendente, sulcis modicis subrectis, tertias longitudinis capitis efficientibus. Genæ majores verticales. Oculi minores, haud distantes, à glabellâ dimidio lati-

tudinis ejus via sejuncti; á margine postico distantiores. Anguli —? Thorax capite longior, è annulis 10 latis confectus, quorum axis modicus, sulci axiales profundi. Fulcra proxima; pleuræ rectæ, longitudinaliter striato-costatæ, apicibus truncatis. Cauda oblongo-ovata, ad mediam partem gibba, angulis truncatis, axe brevi, angusto, supernè conspicuo, intus 3—4-annulato. Margo caudæ nequidem recurvus; fascia lata concava, striis imbricatis paucis imbricata.

It is sad patchwork reconstructing this species, though we have plenty of fragments—heads without cheeks, a distorted but complete thorax, and several tail-pieces, all of which show a strong granular character of the inner crust, which is exhibited by short broken lines and puncta in the cast. Even fragments show this character. The species is pretty common in the Coniston limestone; and all who know that rock know what a vast amount of cleavage and distortion the fossils have undergone.

Nor are we quite certain about the name. Eichwald's figure truly represents a Scandinavian form distinct from the common *Il. crassicauda*, and very much like ours, with broad thorax-rings, and the eye placed near the furrows, and rather forward, compared with such species as *Il. Bowmani*, which occurs with it, and has no granular surface.

But in the 'Memoirs Geol. Survey,' vol. ii, pt. 1, when describing this species which I had already distinguished and figured for Prof. Sedgwick's book (the figures quoted are drawn by me), I unfortunately included with it and figured for it the *Il. Murchisoni* described at p. 201. I gave it the same name in the Appendix to the 'Woodwardian Synopsis' above quoted, and thereby vitiated both descriptions. I must, therefore, go over the ground again, as we usually have to do when in a hurry; the Coniston limestone species is the one intended, and should it prove distinct, as I think it will, from Eichwald's fossil (which seems not to have occurred to Prof. Angelin in his Swedish collections), I propose to name this conspicuous Westmoreland fossil *Il. Marshalli*, after the gentleman who has done so much to help forward the study of the Westmoreland fossils.

It is larger than *Il. Bowmani*, and nearer five than four inches long; of a lengthened shape, both the head and tail semioval, with blunt extremities; gibbous, especially in front; deeply trilobate, and marked all over the cast with short wavy impressed lines and puncta. The glabella-furrows are more direct, longer, and converge more than in *Il. Bowmani* (we need not compare it with *Il. Murchisoni*, with which I formerly confounded it). The shape of the head is not very clear, but it is nearly as long as wide, very gibbous forwards, and overhanging like that of *Il. crassicauda*, which species it resembles.

The glabella-furrows are sigmoid, but only slightly converging, and bent out above; they extend forwards twice as far from the posterior margin as the place of the eyes, more than one third, but not half-way up the head (our figure has them rather too much curved). The small eyes are placed about as far out from the glabella as half its width (in *Il. Bowmani* they are two-thirds its width away), and they are placed once and a

half their own length from the hinder margin, while in the kindred species they are only their own length in front thereof.

Thorax deeply trilobate; the arched rings broad, and flat from front to back; the pleuræ are equal to the axis in width, and are arched forwards instead of at all backwards; their fulcrum is extremely close to the axial line, seemingly about one fourth out, and from thence the pleuræ are covered by longitudinal lines, not very close-set; their ends are truncate.

The tail (in the figured specimen from the Woodwardian Museum) is compressed; but it was evidently convex; with a narrow axis, defined by broad and rather deep axial furrows, which extend, however, but a short distance, and do not much converge. The axis shows four annulations within the crust (our figure has too many). The sides slope evenly down to the thickened margin, which is not at all flattened or recurved; and the internal fascia is concave, broad, and coarsely and remotely striated with imbricate sculptured lines.

I have described the original specimen, but believe the caudal shield fig. 5, which does not show the axis ribbed, to be the same, and to show the true form of the tail.

Locality.—Coniston; Sunny Brow; and Horton in Ribblesdale, Westmoreland. In CARADOC or BALA LIMESTONE (figs. 2, 4, Woodw. Mus.); fig. 5, Mr. Wyatt-Edgell's Cabinet.

ILLÆNUS (ILL.) MURCHISONI, *Salter*. Pl. XXVI, fig. 1, and Pl. XXX, fig. 7.

ILLÆNUS ROSENBERGII, *Salter*. Mem. Geol. Surv., vol. ii, pt. 1, pl. v, figs. 6—8, 1848. Not of Eichwald.

— MURCHISONI, *Id.* Sedgwick's Synop. Woodw. Mus., Fasc. 1, Appendix, p. iv, 1852; description only. (Only exclude figures of Westmoreland specimens, pl. i g, figs. 33—35, which are *Il. Rosenbergii*.) See p. 199.

— — *Id.* Decades Geol. Survey, No. 2, Art. ii, p. 4, 1849.

Il. (Illænus) magnus, 6-7 uncias longus, ellipsoideus, obtusus, convexissimus, capite et thorace ejusdem longitudinis, caudâ vix minori. Caput pars quarta sphaera est, sulcis axialibus brevibus, rectis, haud ultra oculos tractis. Oculi majores, vicini, à margine postico diametrum suum distantes. Anguli capitis quadrati. Thorax longus, axe latissimo pleuris subrectis longé latiori, ad fulcrum proximo. Cauda convexa semicirculata, angulis haud truncatis, margine obtuso; axe obscuro lato, fasciâ angustâ.

More desirous to identify the closely related forms of this genus than to multiply species, I too hastily (in 1852) united the fossil from Llandeilo that is figured in the 'Survey Memoirs' with one which is common in beds of the same age in Westmoreland. The latter will be found in p. 199, and I believe it to be the true *Il. Rosenbergii* of Eichwald. The Llandeilo species, however, is clearly distinct, as pointed out by myself in the Appendix to Prof. M'Coy's 'Woodwardian Catalogue' and, as there are two

species, I must restrict the name to the fossil first figured. That was a crushed specimen; but the finest possible examples have since been obtained from the same locality; and my friend Mr. J. E. Lee, of Caerleon, possesses the best,—our figured specimen. Except the Barr Trilobite, which it much resembles, we have no species of equal bulk in Britain. It is a Bala Limestone fossil; the Grug and Birds Hill quarries being in that rock.

A large and extremely convex species, generally about six or seven inches long. The form a long ellipse, the length being to the breadth as 11 : 5. Head about equal to the thorax, or slightly longer, and the tail a little shorter than either. The head is truly a quarter of a sphere, with square head-angles, and very slightly trilobed by shallow axial furrows, which converge but little, are sigmoid, and reach to the top of the eyes.¹ The glabella thus marked out is not wider than the cheeks. The eyes are large for *Illæus* proper; narrow, with no furrow beneath them, and near to the axis—scarcely a third of the glabella's width away from it. The cheeks steeply decline towards the eyes, and are thence nearly vertical to the blunt margin. The angles, though called square in the diagnosis, are more acute than a right angle, and the corner is rounded off; still the aspect is unusually square for the genus. The shape of the free cheek, from the very outward curve of the facial suture above the eye, is a trapezoid; the side nearest the eye being about one half that opposite to it—viz., the margin.

The convexity of the head is such that a line taken transverse to the eyes would be a semicircle, and that from vertex to front a quarter of a circle. On the underside, the coarsely striate² rostral shield (epistome) is as wide as the glabella, and is itself about twice as wide as long. It is narrowed on either side, more so than in *Il. Bowmanni*, and abruptly broader in the middle. And in this form it differs again from the more oval shield of *Il. (Bumastus) Barriensis*, between which and this species there are many points of resemblance that strike the eye at first glance. Indeed, *Il. Murchisoni* leads from the true *Illæni* to that subgenus, as may be seen by what follows.

The trilobation of the thorax is not very distinct, the axis being almost as broad as that of *Bumastus*, but much more pronounced than in that subgenus.

The thorax of ten rings is about five sixths the length of the head. The greatest breadth of the axis is in the seventh and eighth body-rings, where it is double that of the pleuræ; in the first ring, as the axis is spindle-shaped, the breadth to that of the corresponding pleura is 4 : 3; in the last ring it is 3 : 2. The fulcrum is placed at one third in the first ring, and at one half in the eighth, ninth, and tenth. The pleuræ, flat as far as the approximate fulcrum,³ thence slightly bent down, and inclining backwards.

¹ Within the crust, on the cast, they show strongly the glandular? depressions opposite the eye, as in *Bumastus Barriensis*, but not so large. These impressions are as yet very problematical. Can they be muscular attachments? I think not.

² The striæ are coarsely imbricato-striate, as in *Il. Barriensis*. They are parallel in front with the anterior edge, and behind with the posterior edge; in the middle, nearly direct across.

³ When the axis is broad, the fulcrum must be always approximate (for mechanical reasons connected with the rolling up), except in very flat Trilobites.

The tail is convex, but not uniformly so, the anterior part and the line of the axis generally being rather flattened. Thence, towards the margin, it is bent down abruptly. The breadth of the tail exceeds the length by about one half the latter; the posterior margin is a semicircle, and the anterior a slightly wavy line (Pl. XXX, fig. 7), on which the broad axis is marked out by shallow indentations, and the angle at which the facet starts a very obtuse one, so that the angles of the tail are scarcely more truncated than in the "Barr Trilobite." There are but slight indications of very shallow axial furrows, but the anterior lateral furrow of the tail beneath the fulcrum is quite distinct. The fascia is slightly convex, and has coarse striæ; it is very narrow. The inner surface of the tail rough, with small points or tubercles.

Locality.—CARADOC or BALA Limestone, at Grug and Birds Hill, close to Llandeilo. (Mus. P. Geol. and Mr. Lee.) Chair of Kildare (Mr. Wyatt-Edgell's Cabinet).

Bumastus follows next in order of affinity; for though technically *Ectillænus* and *Illænopsis* are in the trilobed group, they are so different structurally, on account of the position of the eye, that we may well believe they will form distinct genera by-and-bye. I shall not follow, therefore, the order of the numbers, but place the above-named two sub-genera last. And we now come to the highest, if not the most typical *Illæni*, viz. the Upper Silurian forms of *Bumastus*, distinguished by the great solidity and fine sculpture of the shell or crust, the convexity of the body, the full number of body-rings, largely developed eyes, &c. In this group the trilobation of the tail, all but lost in some of those above described, is altogether absent, and that of the thorax nearly so.

Subgenus 5.—BUMASTUS, *Murch.*, 1837.

ILLÆNUS (BUMASTUS) BARRIENSIS, *Murchison*. Pl. XXVII, figs. 1—5.

"A new species of Trilobite," *F. Jukes*. Ann. Mag. Nat. Hist., vol. ii, p. 42, figs. 8, 9, 10, 1829. "Probably Isotelus," *J. De C. Sowerby*, ib. p. 45. *Silliman*, Amer. Journ. of Science, vol. xxiii, i, p. 203, 1833.

BUMASTUS BARRIENSIS, *Murchison*. Sil. Syst. (description, but not figures), p. 656, pl. vi bis, 1839.

— — *Emmerich*. Dissert., p. 33, 1839.

NILEUS? (BUMASTUS) BARRIENSIS, *Burmeister*. Org. Tril., p. 120, 1843. Ib., Ray edition, p. 104, 1846.

¹ The highest and lowest forms of a group are not typical: there is in most natural groups a central form combining all the chief characters. At least that is my idea of type. *Asaphus* is typical of the *Asaphida*; it is not the highest form. *Acaste* is the typical *Phacops*; and so forth.

BUMASTUS BARRIENSIS, Hall.	G. R. New York, p. 102, No. 10, fig. 4; No. 19, fig. 3, 1843.
— — Id.	Pal. New York, vol. ii, p. 302, pl. lxxvi, figs. 1—15, 1852.
ILLÆNUS — Id.	18th Rep. State Cabinet (Dec. 1864); possibly also <i>Il. imperator</i> , id.
— — Salter.	Decades Geol. Surv., No. 2, pl. iii (excl. fig. 2), and pl. iv (excl. figs. 9—11), 1849.
— — Id.	Siluria, 2nd ed., p. 123, Foss. 16, fig. 2 (not plate), 1859.
[NILEUS GLOMERINUS, Dal. Arsberätt., p. 136, 1828; Hisinger; Leth. Suec., p. 16, 1837?]	

Il. (Bu.) magnus, squamoso-striatus, 6-uncialis, obtusè ovatus, valdè convexus nec gibbus, capite semicircularato, caudâ transversâ. Caput obtusum sub-truncatum, marginibus obtusissimis, sulcis axialibus brevibus valdè convergentibus. Oculi longi haud deflexi, pulvillo longo fulti, sulco lato profundo circumdati. Anguli obtusi. Cauda transversa, semicircularata, convexa.

This far-famed and common Trilobite has many claims to distinction. Of great actual bulk, for it is remarkably convex; and of no mean linear dimensions, being often nearly 6 inches in length by $3\frac{1}{2}$ in breadth; with the remarkable even contour which induced Sir Roderick to maintain its claims to generic distinction; with a definite geological horizon, the Lower Wenlock, and with a range from New York to Sweden,—the species, which is a peculiarly abundant one, is perhaps as good an Upper Silurian type as can be pointed out. And the beauty of the specimens, the finest known of which are, I believe, figured on our plate, renders *Il. Barriensis* a general favourite. The largest perfect individual extant is in the cabinet of Miss Jukes, of Birmingham; and as it was carefully figured sixteen years ago in the Decades of the Survey, we have been contented to copy that figure, improving it from a good cast. This specimen is $4\frac{3}{4}$ inches long by 3 inches 4 lines broad at the head. But our fig. 1a, from the Museum of Practical Geology, indicates a yet larger size,—it must have been nearly 6 inches in extreme measurement.

It may as well, however, be here stated, that the name *Barriensis*, though evidently intended by Sir R. Murchison for the well-known “Barr Trilobite,” was applied by himself, and subsequently by many different authors, to another and a very distinct species. The figures given in the ‘Silurian System’ represent a fossil which I had already distinguished by the name *Il. pomatia*, before I received Prof. Hall’s last paper on the fossils of the Niagara group from the Western States. It would be wrong in principle to apply the name intended to designate the common Woolhope Limestone species to another fossil, because that one happened to be figured (in mistake) by its author; and I think I shall have the consent of all paleontologists to keep Murchison’s well-known name for the “Barr Trilobite,” while Prof. Hall has furnished us with a name for the Dudley one, viz., *Il. insignis* (*Il. pomatia* of our Plate). I subjoin comparative figures of the three Upper Silurian species of this section of the genus, that the distinctive characters may be better appreciated.

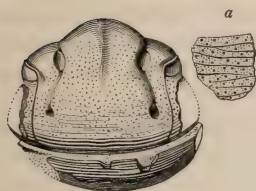
From the *Illænus insignis*, next described, and usually confounded with our fossil, *Il. Barriensis* is at once distinguished by the more depressed shape, the head being regularly

and gently convex and obtusely margined, while that of *Il. insignis* is pyramidal and the margin recurved. The latter species is abundant in North America, as described by Hall; and I do not know if the huge *Il. imperator*, lately described as a distinct species by that author (Reports, Dec., 1864), be different or not. It may be, for aught in the description, a giant form of this large species.

It will be perceived that these three species differ in form and sculpture. *Il. Barriensis* is depressed in the front view (fig. 53), and has coarse squamate striæ in front. *Il. insignis* (fig. 52), more elevated, and with a deep pit where the obscure glabellar furrows end, has very fine ornamental striæ. *Il. carinatus* (fig. 53), the most gibbous of all in a front view, has the axial pits like *Il. insignis*, and the coarse striæ, less universal than in *Il. Barriensis*.

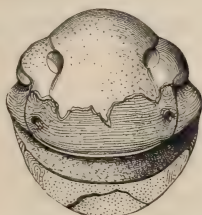
BRITISH UPPER SILURIAN ILLÆNI of the Section BUMASTUS.

FIG. 51.



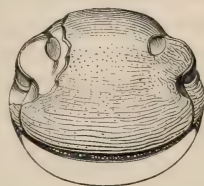
Il. carinatus, Salter.
Wenlock Limestone, Malvern;
a rare species.

FIG. 52.



Il. insignis, Hall.
The common Dudley fossil,
usually called *I. Barriensis*.

FIG. 53.



Il. Barriensis, Murch.
Very common in the Woolhope Beds
and Wenlock Shale.

Il. Barriensis is broad-oval, with blunt extremities and arched sides. The head measures very nearly an inch and a half long, and is therefore rather less than a third of the whole length. The tail is exactly as long as the head,—the body (of 10 arched rings) occupying one inch ten lines, and being therefore longer than either. The trilobation is extremely faint, and the breadth of the axis as great proportionally as in *Homalonotus*. The fulcral point nearly coincides with the faint axial line (it can scarcely be called a furrow). However, the axial furrows are strongly marked out for a short distance in the head; and we may now describe that portion.

Head forming nearly a quarter of a sphere, and not more pointed in the young than in the old state, the front being obtuse in all ages, and more flattened anteriorly and on the sides than a true semicircle. It is depressed, the vertical height being only half the width; and the convexity being spread over the whole surface, the view of the front edge (woodcut 53) presents a semicircular outline instead of a subpyramidal one. The edge is blunt and convex all round, not at all recurved. The axial furrows converge very strongly

above the large eyes, which, in Miss Jukes' specimen, are $2\frac{1}{4}$ inches apart, measuring to their outer edges. The furrows terminate above the eye (but only on the inner surface of the crust) in oval depressed spaces, the nature of which is not yet known, but which probably represent a pair of the curious glands(?) described under the genus *Phacops* (see under *P. caudatus*, p. 52). Beneath the eye, a strong rounded fold or long cushion (*pulvillus*) of the crust supports that organ (the fold is not seen in young specimens), and this cushion is subtended by a deep furrow, that encircles the whole of the lentiferous surface of the eye. The latter is much curved, and quite smooth, and has a thick cornea. The encircling furrow ends in front in a broad deep depression (Pl. XXVII, fig. 16) which indents the head deeply just at the origin of the facial suture above the eye; the suture from thence curves boldly S-fashion out to the margin, which it cuts on a line level with the outer edge of the eye. Beneath the eye, the suture again turns sharply outwards, cutting the posterior margin in the same vertical line. The eye-lobe (*palpebra*, Dalman) is very convex and inclines downwards. The inferior fold or eyelid, if so it may be called, is deeply punctate in our specimen, but without any of the wavy lines which cover other parts of the head. (Decade 2, Geol. Survey.) The cheek, outside the eye, is tumid, and the angle quite blunt. The neck-furrow is always obscure in the species of this genus. The whole head is covered with the peculiar squamous lineation characteristic of the family *Asaphidae*; its peculiarities are more particularly described below.

The epistome beneath the head is broad, and very strongly striated transversely by sharp squamous striae. (See Decade 2, Geol. Survey, pl. iv, fig. 7.) We have omitted to figure it again in our plate. The rostral shield is very distinct, and often found separate in this and other species of *Illæus*; it is a transverse piece, long-oval in shape in our fossil (many of the species have it rhomboidal) and with pointed ends; the rostral suture is very distinct, and the sutures that separate it from the side-pieces equally so. The labrum should be looked for. It is strange it should not be yet known in collections.

Thorax of 10 segments, arched forward, especially the front ones, and having the three lobes just indicated by a very slight furrow where the fulcrum is placed, the sub-fusiform axis occupying more than two thirds the entire width of the thorax. The fulcrum is, of course, far outwards; and is formed by a short forward bend of each pleura, which then continues in the general direction, is sharpened anteriorly for rolling, and curves forward at its blunt end; the foremost pleuræ are rapidly shortened, the whole of the lateral portions of the great head projecting beyond them (fig. 2).

Tail, in the young state, transverse broad-oval; and in the adult not much more than a semicircle. The upper corners are truncated, the facet strong. There are no indications at all of the axal lobe, and the whole tail is regularly and gently convex from side to side, and from front to back; and is not nearly so hemispherical as in the next species. The incurved portion (caudal fascia) is broad and not so convex as in the next species, *Il. insignis*. It is, however, remote from the inner surface of the crust, leaving a hollow channel, which is conspicuous enough in broken specimens.

The general sculpture of the surface is coarse, and is arranged thus: on the head it lies transversely, and is very strong along the front margin; in old specimens (fig. 2) it appears quite squamous there. For half the length of the head it follows the direction of the front margin (woodcut, fig. 53), and is then met rather abruptly, above the level of the eye, by the more direct and fainter lines of the middle portion, and here the lines inosculate. Behind, the head shows somewhat finer lines, and a central tubercle some way up (see fig. 1a). Among the coarse striæ are abundant puncta, wide and strong, the marks, probably, of the bases of short pile or stiff hairs. Similar lines, mixed with puncta, run transversely across the whole thorax, parallel to the course of the rings; both, however, vanish about the fulcral points. The puncta are not closely placed on the caudal shield.

British Localities.—MAY HILL SANDSTONE, Malvern (M. P. G.); Purple shales, Onny River, Shropshire (Mr. Wyatt-Edgell's Cabinet). WOOLHOPE? GRITS of Bogmine, Shelve, Shropshire, rare (M. P. G.). WOOLHOPE LIMESTONE of Woolhope, Herefordshire (abundant); Hay Head, Barr, Staffordshire; Malvern Tunnel (abundant); WENLOCK SHALE of Rushall Canal, near Wallsall (the late Mr. Mushen's Coll.). WENLOCK ROCKS of Llandeilo; Llandovery; Carmarthen; &c., as far as Freshwater, Pembrokeshire (M. P. G.).

Foreign.—NIAGARA LIMESTONE, New York, Wisconsin, &c.

ILLÆNUS (BUMASTUS) INSIGNIS, *Hall*. (*Il. pomatia*, on plate) Pl. XXVII, figs. 6, 7.

ILLÆNUS BARRIENSIS (in part), *Murchison*. Sil. Syst., p. 656, pl. vii bis, fig. 3; pl. xiv, fig. 7, 1839.

— — *Hall*. Geol. Rep., New York, p. 102, No. 10, fig. 4; No. 19, fig. 3? 1843.

— — *Salter*. Decades Geol. Survey, No. 2 (pl. iii, fig. 2; pl. iv, figs. 9—11 only); Siluria, 2nd ed., pl. xvii, fig. 9—11, 1859.

IL. INSIGNIS, *Hall*. 18th Report on the New York State Cabinet for 1865 (printed in advance, Dec. 1864).

Il. modicus, 3-4 *uncialis*, *capite parabolico*, *caudâ hemisphæricâ*. *Caput gibbosum anticè ovatum, margine reflexo; sulcis axalibus primûm convergentibus, dein longè divaricatis et in foveas angustas desinentibus. Oculi humiles deflexi, pulvillo nullo fulti. Anguli obtusi. Cauda subhemisphærica, tam longa quam lata fere, margine acuto. Superficies, caput præcipuè, lineis creberrimis.*

As above noted, this fine species has all along been confounded with the *Il. Barriensis*, from which it differs in every particular. More convex, with obliquely placed eyes, which have no fold beneath them—deep pits (*foveæ*) at the end of the axal furrows in front of the eyes—a close lineation of the surface; and above all, a highly convex tail-piece, which is subhemispherical and nearly as long as broad,—these are characters which distinguish the species, at a glance, from the much more common *Il. Barriensis*.

It is not nearly so large a fossil as the last, probably never more than 4 inches, but

with head and tail so very convex, that when extended only a small portion of the former is seen in a vertical view; while the whole length of the thorax, when not rolled up, is two thirds that of the tail. The pointed or rather parabolic head, when viewed directly in its full measure, is 18 lines long, by 22 broad, and the depth 11 lines (much deeper, therefore, than in *Il. Barriensis*). Of this breadth the glabella, which is strongly marked only in the cast, occupies 14 lines at the base; thence the furrows quickly converge forward to the deep kidney-shaped depression (or gland) above the eye, and thence again diverge to the curious pits¹ near the front of the head. The glabella is most gibbous on the vertex, but is not carinate as in the next species.

From the axial furrows the eye-lobe descends rather rapidly to the *depressed* long lunate eye, which is subtended by a furrow, but by no raised fold of the crust, as in *Il. Barriensis*; nor does this furrow terminate forward in a deep wide depression, as in the larger species. The eye is placed at less than half its length from its margin; the facial suture turns sharply out beneath, but cuts the margin under the eye, not beyond it. Above the eye it bends strongly out, and reaches the margin on a line *outside* the eye. The whole surface is covered by a close sharp lineation which follows the head-margin, and becomes coarse only on the free cheeks, where the puncta are also very strong. The angles are blunt, but rectangular.

The labrum (figured from a Brit. Museum specimen) is very perfectly preserved. It is wide, triangular, half as wide again as long, straight along the expanded base of attachment, and with nearly straight sides, forming thus a right-angled triangle with a rather acute apex. Its centre is very gibbous, and the convexity declines steeply to the sides, where a broad lateral depression, continuous with the marginal furrow, separates a thickened recurved rim all round: this is broadest on the sides. A pair of compressed tubercles occurs at the lower third: they are transverse-ovate, and more than their own diameter apart. The surface is covered with squamous lines (like those on the body and head) curved strongly, and interlined, like the body-sculpture, with short lines.

The thorax-rings, regularly arched, are each convex from back to front, and have the axial line coincident with the fulcrum. The pleuræ curve forward, and are thickened on the hinder edge, and striated along the facets.

The tail, 18 lines long and 21 broad, is all but hemispheric in contour, and most convex at the hinder two thirds. It has lineations mixed with puncta in front, and all the hinder part is covered with punctations only. The edge of the tail is acute, not really recurved, but not at all rounded downwards. The incurved caudal fascia is not broad, but very convex beneath, and is covered closely with granular elevated striæ. This fascia is continued of the same breadth beneath the pleuræ, as in all Trilobites; and a young specimen in Mr. E. Hollier's cabinet shows that it occupies half the breadth of the pleuræ, a very common proportion in the *Asaphidæ*.

¹ These pits represent what are frequently seen in *Calymene*, *Trinucleus*, and other genera; they are points of attachment for the *alæ* of the labrum.

Young specimens present nearly the same proportions, but the tail is somewhat shorter and the form less convex.

Localities.—WENLOCK LIMESTONE of Dudley, and the Malvern Hills, frequent. It is probably common enough in the Wenlock of other places; but I avoid quoting localities which may belong to *Il. Barriensis*.

Foreign.—NIAGARA LIMESTONE of Illinois and Wisconsin.

[*Illænus orbicaudatus*, Billings ('Catal. Sil. Foss. Anticosti,' 1866, p. 27), is a *Bumastus* so like this that I do not see readily how to distinguish it. It is a Caradoc and Llandovery form, in the Island of Anticosti; but several of our fossils immigrated from the far west in Silurian times; and this may be one of the colonists.]

ILLÆNUS (BUMASTUS) CARINATUS, n. sp. Pl. XXVII, figs. 8, 9.

[Compare with the kindred species, *IL. ARMATUS*, Hall!]

Il. (B.) modicus 2—3-uncialis; capite rotundato gibbo carinato, angulis brevispinosis. Caput gibbosum anticè rotundatum, margine acuto nec recurvo, vertice gibbo carinato; sulcis azalibus primùm convergentibus, dein lentè divaricatis et in foveas desinentibus. Oculi parvi, pulvillo tumido instructi. Anguli in spinas crassas tracti, quæ breves sunt et striatæ. [Cauda forsan transversa.]

This remarkable species, of which we only have two fragments in the Museum of Pract. Geology, and another in Mr. Edgell's fine collection, is one of the rarest of the Wenlock Trilobites. It was detected by myself, after lying for years in the Museum of Pract. Geol. as a variety only of *Il. Barriensis*: a good instance of the desirability, in a public collection, of preserving all the variations that occur, and not reducing the number too greatly. The late Rev. Mr. Dyson, of Malvern, found our specimens in the Winning's Quarry, Malvern. It is closely allied to an American form lately described by Prof. Hall, referred to above; and it may possibly be identical, but differs in the facial suture, and in the proportions. For points of difference from British species, see pp. 204—207.

Comparing our specimens, such as they are, with Prof. Hall's smaller species, I find the following differences, that make me hesitate to unite them. Ours is more gibbous on the vertex, has much smaller eyes, set on a more protuberant cushion; and the facial suture in front of them cuts the margin in advance of the eye—not at right angles to it. Prof. Hall's description is, as usual, far too short and general; he gives no note of the

FIG. 54.



Illænus (Bum.) armatus, Hall.
Niagara group, Wisconsin.

¹ 18th Report New York State Cabinet, printed in advance, Dec., 1864 (see description of *Il. Barriensis*).

sculpture, of the front margin, the depth or shallowness of the axial furrow: nor any characters, other than length and breadth, of the pygidium. Still the two species must be very near indeed. And both are remarkable among the *Bumasti*, for spinous head-angles, a character which we do not know in more than a few instances, even among the typical *Illæni*.

Locality.—WENLOCK LIMESTONE, Winnings Quarry, Malvern. (Museum Practical Geol., and the late Mr. H. Wyatt-Edgell's Cabinet.)

ILLÆNUS (BUMASTUS) MACCALLUMI, n. sp. Pl. XXVIII, fig. 1. Pl. XXX, figs. 2, 3.

Il. (B.) 2 uncias longus, capite obtuso, lunato, caudâ subtrigonâ. Caput gibbosum, oculis majoribus. Thorax subtrilobus. Cauda parabolica, subtrigona fere, lævis: axis ejus latus, ad marginem curvum tantum conspicuus; latera fulcro valde prominente, axe proximo, lævia, nisi sulco superno profundiore distincta. Fascia caudalis angusta.

A few specimens only of this new species have occurred to the Geological Surveyors in the course of their work at Girvan, Ayrshire; and one or two, more complete, are in Prof. Thomson's cabinet. One of his specimens (Pl. XXX, fig. 3) shows nearly all the body-rings and part of the head. From these we learn that the head was so convex as to be almost hemispherical and blunt-edged, while the tail is very little gibbous, and is pointed—an unusual character.

The head seems to have been transverse, lunate; most gibbous in front, with large eyes proportionally, though they are somewhat less than in *Il. Barriensis*, and placed rather further back. The glabella-furrows curve quite round the eyes in front—incurved and then recurved, as in the larger species. The central punctum on the vertex is strong, and a ridge runs from it; but the head is not otherwise at all keeled. Our figure looks a little as if it were so.

Thorax of ten? very much arched rings, which show a very broad axis, as usual in the sub-genus, but a more decided axial furrow than in our two Wenlock species. The pleuræ are short; their apices rounded, and curved forward.

The tail is very regularly but not highly convex—a long half-oval. It is one inch long, and as broad at its upper curved margin, which shows distinctly the axial points, distant from each other fully three fifths of the width of the tail, and deeply indented. These are, however, not continued in anywise as furrows down the tail itself. Almost immediately beyond these points the front margin rises abruptly to the prominent fulcrum, and from thence descends to the contracted outer and upper angles; a sharply marked facet is still further defined by the subtending upper furrow, more strongly indented in this than in any other *Bumastus* known.

The surface of the tail is convex, somewhat gibbous down the central line, and this is not due, except in part, to pressure in the arenaceous rock. From this central line the

sides slope evenly away to the slightly recurved margin, within which the broken specimen shows the narrow internal fascia.

Locality.—LLANDOVERY SANDSTONE (Lower Llandovery Rock) of Mullock, Girvan, Ayrshire; a locality first described by Murchison, and well searched by the persevering collector, the late Alexander MacCallum (see 'Quart. Geol. Journal,' vol. vii, 1851, p. 170), who discovered most of the species in his own district. *Illænus Thomsoni*, *Trinucleus concentricus*, and *Atrypa hemisphærica* occur in the same deposit of hard yellow sandstone and grit, but no *Pentameri*, such as are found in the overlying "May Hill Sandstone" of Saugh Hill.

Sub-genus 6.—ECTILLÆNUS, *Salter*, 1866.

ILLÆNUS (ECTILLÆNUS) PEROVALIS, *Murchison*. Pl. XXVI, figs. 5—8.

ILLÆNUS PEROVALIS, *Murchison*. Sil. Syst., p. 661, pl. xxiii, fig. 7, 1839.

— — *Salter*. Siluria, 1st ed., pl. iv, figs. 13, 14, 1854. 2nd ed., pl. iv, figs. 13, 14, 1859.

— — *Id.* Morris' Catal., 2nd ed., p. 110, 1854.

— — *Id.* Catal. Mus. P. Geol., p. 5, 1865.

— — *Id.* Mem. Geol. Surv. iii, p. 256, 1866.

Il. (Ectill.) latè ovatus, obtusus, depressus, 2½ uncias longus, 2 uncias fere latus; capite semicirculato, quam cauda minore, sed thorace brevi paullo longiore; oculis anticis submarginalibus. Caput glabellâ angustâ, haud tertias latitudinis ejus efficiente, sulcis axalibus brevibus rectis. Oculi (?) suturaque facialis omnino antici submarginales; anguli obtusi. Thorax bene trilobus, axe angusto subfusiformi, pleuris angustiori. Pleuræ ad fulcrum (circiter tertias posito) planæ, dein fractæ, subrectæ, apicibus obliquis. Cauda margine antico subrecto, axe brevi conico. Fascia angustior, subconcava.

This remarkable species, certainly the type of a very distinct sub-genus (probably a new genus), was first obtained by Sir R. I. Murchison from the lower part of the Llandeilo formation, in the Shelve country, west of the Stiper Stones. In the 3rd vol. of the Memoirs of the Survey, I have inadvertently included it in the Arenig group, but wrongly so: see above, p. 182. This I learned by a visit to St. David's, where Mr. Hicks, Mr. Lightbody, and myself obtained a good specimen from the lower part of the true Llandeilo rocks at Aberiddy Bay, near Llanrian (fig. 8); and Mr. Thos. M'K. Hughes, of the Geological Survey, had some time previously obtained a similar specimen (fig. 7). These are larger than Murchison's specimens in the Geological Society's collection, and show more clearly what must be the true position of the eye, *if there be one*. With this Trilobite is found, but rarely, the double Graptolite *Didymograpsus Murchisonæ*, so that its place in the series is unquestionable, for the Graptolite just mentioned is a typical Llandeilo fossil.

We still want to know more about the head of this species, probably not a rare one; and the small free cheek has not yet been found. It must have been quite narrow; very

probably it is soldered to the head, and in that case the eye (indicated by a notch at *a*, fig. 8) may be absent, and the species a blind one. Collectors should search for the species in its original locality, between Corndon Hill and Hope Mill, Shelve, Shropshire.

A broad-oval species, two and a half inches long by two inches broad, of which length the semicircular head is rather longer than the thorax, and shorter than the semicircular tail. The axis is well marked out and narrow in the thorax; very slightly so in the head and tail. The semicircular head, with bluntish angles, is very slightly convex, but regularly so; and has short axial-furrows reaching a third up and nearly straight, marking out a glabella so narrow as not to be nearly a third of the whole width. The facial suture is all but marginal, and must cut the exterior edge about half-way up; while the place of the eye, indicated by a notch (the eye has not been found), is fully two thirds up the head. The free cheek, therefore, as before said, must be very small, narrow, and triangular.

Thorax well lobed, the axial furrows sharp, the axis subfusiform, narrower, but not greatly so, than the nearly direct pleuræ, which are flat as far as the fulcrum: this is placed about one third out, and nearly equally distant in all the rings. The outer portions of the pleuræ are neither recurved nor deflexed, but run straight out; and they are oblique at the tips.

Tail semicircular, the front edge straight or a little arched, with a very short narrow conic axis, which indents about one fourth of the length of the tail. The upper angles of the tail are very slightly truncated, and obliquely so. The surface is regularly and only slightly convex. The fascia—seen best in Mr. Lightbody's specimen (fig. 8) and in Sir Roderick Murchison's specimen (fig. 5)—is moderately broad, and of tolerably equal width all round.

Localities.—LLANDEILO FLAGS proper (lower portion); near Hope Mill, north of the Corndon Mountain, Shropshire (Mus. Geol. Soc., figs. 5, 6). Near Llanrian, Abereiddy Bay, Pembrokeshire, (Mus. P. Geology, fig. 7, collected by Mr. Hughes; fig. 8, in Mr. Hicks' Cabinet).

Sub-genus (?) 7—ILLÆNOPSIS, Salter, 1865.

I can hardly believe this to be less than a generic group; but prefer to keep it with *Illænus* for the present, as the Canadian sub-genus *Hydrolænus* so much tends to connect it with the more ordinary forms. But while the anterior eye resembles *Ectillænus* just described, the complete axial furrows show a tendency towards *Bronteus*, and the grooved and pointed pleuræ link it more with the ordinary forms of the *Asaphidae* than is exhibited in any other of the *Illænus* group. Perhaps *Psilocephalus* is the nearest genus we can compare it with. And it is instructive to observe that *Psilocephalus* preceded *Illænodesis* in point of time; and *Illænodesis* and *Hydrolænus*, with complete furrows and forward eyes, preceded *Ectillænus*; and so far as I am aware, this latter sub-genus was rather an earlier one than *Illænus* proper. The group closed with the highest and

most perfect form *Bumastus*, in which the characters of the group may be said to culminate. As only one species is known, it is desirable to unite the generic and specific characters in description.

ILLÆNOPSIS THOMSONI, *Salter*. Pl. XX, fig. 1.

ILLÆNOPSIS THOMSONI, *Salter*. Mem. Geol. Survey, vol. iii, pl. 11 B, figs. 1, 2, pp. 256, 316 (not of the May Hill, or Upper Llandovery list in p. 360, which is a misprint for *Illænus Thomsoni*), 1866.

Il. modicus, viz 2 uncias longus, $1\frac{1}{10}$ latus, ovatus; capite convexo obtuso, sulcis conspicuis; oculis anticis. Caput semicirculatum, convexissimum. Glabella urceolata, genis multò latior, sulcis axialibus profundis supernè divaricatis et ad marginem deductis. Oculi parvi antici, marginales, angulo glabellæ insidentes. Pleuræ cuspidatæ, sulcatæ. Cauda (huic speciei haud dubiè referta), semicirculata, axe longo distincto; sulco superno conspicuo. Fascia angusta, axem attingens.

I have shortly described this form as "ovate, the head very convex, with widely divergent axial furrows reaching to the front; technically, the axial furrows are complete. Fixed cheeks large; free cheeks small and anterior; the eye placed close to the front margin; facial suture ending on the outer margin; pleuræ pointed, grooved." [Tail margined, and with complete axis.] See 'Mem. Geol. Surv.,' vol. iii, 1866.

Head semicircular, very convex; rather more so in front, but not gibbous. The glabella, much wider than the cheeks, is marked out by two strong deep furrows, parallel below, but curving out so much above as to give a sheaf-like look to the glabella. The axial furrows continue quite to the front edge, as strong as at the base; and at the front they overhang the small eye, which is close to them. The eye-lobe is not raised. The eye is placed in a rather deep notch, and so close to the front margin that the free cheek (separable, certainly, for it is absent) must have been quite minute and the facial suture all but marginal. Below, the wide fixed cheeks have rather a strong neck-furrow, which does not, however, extend beneath the glabella at all.

Of the thorax we have only the two upper pleuræ, but these are characteristic. Much shorter than the width of the cheek, they present a triangular-pointed outline, the tips being acute and a little curved forwards; a strong oblique groove traverses most part of their length.

The tail found with this head can hardly belong to any other species. It is semicircular, with very slightly truncated front angles; and has the axis distinct for fully four-fifths the length of the tail, and marked sharply out all round (another reason for regarding *Illænopsis* as a genus intermediate between *Illænus* and *Asaphus* or its allies). The axis is narrow, rather more than a fourth the whole width of the tail, and with the first ring strongly marked out, at least in the cast. The sides are smooth, except the

rather strong upper furrow. The fascia complete, narrow, and equal all round. I know no fossil that can be a very close ally of this, unless it be the *Illænus conifrons* of Billings, figured by that able palæontologist from the Trenton group of Canada. Perhaps, as suggested by me in the 'Survey Memoirs,' vol. iii, *Il. conifrons* may be of this genus; but it differs in so many respects that I have even ventured to constitute it a distinct sub-genus. *Il. clavifrons*, Billings, and also *Il. arcturus*, Hall, from the Lower Silurian rocks of New York and Canada, have the eye forward, but not nearly so much so as ours. I beg to dedicate the species to my accomplished friend and fellow-worker Prof. Wyville Thomson, whose help to me, both as a thorough naturalist and the owner of a choice cabinet, is invaluable.

Locality.—ARENIG ROCKS; Ritton Castle Mine Works, near Bogmine, Shelve, Shropshire (Mus. P. Geology); in a lead-coloured soft shale (not slate), which abounds in well preserved and rare fossils.

More profitable ground to work than this locality I hardly know in Britain. Two species of *Eglina*, the rare *Trinucleus Murchisoni*, *Agnostus Morei*, an undescribed *Asaphus* or *Ogygia*, and a new *Cheirurus*, are found there. With them occur the Twin-graptolites of two species; the characteristic *Obolella plumbea*; bivalve Shells; a *Theca*; two species of *Orthoceras*; *Bellerophon*, &c. This and the neighbouring mine-work of Cefn Gwynlle are the best localities for well preserved fossils in the Arenig or Skiddaw group; and it was by finding fossils there that I was enabled to establish the existence in 1857 of a distinct fauna for this formation, which had been previously named by Prof. Sedgwick. It is a more extensive group than the Llandeilo proper, and has its representative abroad in the fossil-bearing slates of Brittany (Angers, &c.), so celebrated for their great Trilobites. The fossiliferous Lower Silurian schists of Oporto are probably of the same age. Collectors of Trilobites may therefore expect to find in the lead-bearing rocks of the Shropshire district some of the curious Trilobites described by De Verneuil, Sharpe, Rouault, and Barrande,—such as *Placoparia Zippei* and *Pl. Tournemini*.

I think I shall be doing good service to our science by pointing out where a rich harvest of new forms may be expected, and I hope our friends will send me (for examination at least) some of the first-fruits.

The shales and sandstones west of the Stiper Stones; the slates under the Arenig and Cader Idris porphyries; those of Ty-obry in the pleasant Tremadoc district; the lower and larger half of the Skiddaw Slate; and the prolific vertical shales of White-sand Bay and Ramsey Island, St. David's, should all be thoroughly worked by those who wish to add new forms to our Trilobitic faunæ.

I take this opportunity also to include in the Arenig formation the puzzling Budleigh Salterton pebble-bed. In former pages of this work it was provisionally referred to the Llandeilo rocks. This pebble-bed (the record of vanished rocks hard by in the old time) and the quartz-rocks of Gorran Haven, S. Cornwall (which are relics of the

same old land) will be worth searching for the fossils of the 'Arenig or Skiddaw group,' for many years to come.

To finish the description of this large genus, I may add figures of one or two doubtful forms, respecting which some information is desirable. Two of them are referred to at p. 186.

Fig. 55 represents the original specimen of Prof. M'Coy's *Illænus latus*, from the Wrae limestone of Peeblesshire. I regard it as only a pressed and shortened head of *Il. Bowmanni*, altered by cleavage action so as to destroy the proportions. The glabella-furrows, however, are rather shorter than usual; and unless we had the body and tail, it would be difficult to prove it to be that species.

Locality. Bala Limestone; Wrae quarry, Peeblesshire.

Fig. 56 is a figure of the species found in the true Llandeilo Limestone of Knockdolian, Ayrshire. I should have little hesitation in describing it as *Il. crassicauda*, which I have before said, p. 193, has never certainly yet occurred in Britain; but the greatly truncated angles of the tail are sufficient to make me for the present quote it with doubt. The shape of the tail is identical with that figured by Dr. Volborth as the common Russian species, and the caudal fascia is of a like breadth: it is very much broader than any British species with which it can be compared, except *I. Portlockii*, pl. xxvi, fig. 3; but the less breadth of the axis, and the more remote fulcrum, as compared with that Caradoc species, are characters in which it resembles *Il. crassicauda*, which comes from Llandeilo rocks.

Fig. 57 is a small imperfect head of a *Bumastus* from the Bala (or Hirnant?) Limestone near Chirk. It is a solitary specimen, and only shows enough to prevent our identifying it with either of the four species of *Bumastus* figured in our plates. The head is not at all carinate, as in *Bumast. Maccallumi*, pl. xxx, nor are there any glabella-furrows visible. But this may be because we have here the outside crust, which we do not know in the Ayrshire species. It is worth figuring, to incite collectors to search for it in its locality, a prolific spot, and one which contains many rare fossils.

Locality. Upper BALA (or Hirnant) Limestone of Mynydd Fron Frys, near Chirk (presented to the Woodwardian Museum by the late Mr. Bowman in 1841).

Perhaps other portions of these species will arrive in time for our promised Appendix. Meantime we have their *disjecta membra*.

FIG. 55.



Illænus Bowmanni?
(*Il. latus*, M'Coy: Peeblesshire).

FIG. 56.



Illænus crassicauda, Wahl.?
Llandeilo Limestone of Knock-
dolian, Ayrshire.

FIG. 57.



Il. (Bumastus), sp.
Mynydd Fron Frys,
near Chirk.

We next take up the *Bronteidæ*, a small group in Britain, but a very large one on the Continent. They are closely allied to the *Ogygides* through *Barrandia*.

FAMILY—*BRONTEIDÆ*, BARRANDE, 1852.

If M. Barrande did not actually add the family termination to the name, he showed clearly that *Bronteus* constituted a family group distinct from any other. Originally confounded with *Asaphus* (or rather *Illænus*) by Brongniart, the generic rank of *Bronteus* was perceived by Emmerich, and seized upon by the diligent Dr. Goldfuss, who named the genus in 1839. The name *Brontes* had, indeed, been previously applied to one of the Coleoptera, and it is against all rule to admit a double employ of the same name in zoology. Yet Dr. Koninck's proposition to honour the Bonn Professor by the term *Goldius* has met with no concurrence, and the original name is still preserved.

Dr. Beyrich, who described several of the species first, was the earliest to perceive the necessity of subdividing the cumbrous genus. His view of its relations was not so clear, for he endeavoured to unite it with the *Cheiruridæ*, to which, indeed, as Barrande has pointed out (and, indeed, he seems half inclined to follow the Dr.'s suggestion), the analogies are close. The granulated eye, the short axis and radiated pleuræ of the tail-piece, no doubt suggested this comparison to the naturalist who was the first to accurately describe both genera. But there is, I think, no real affinity between them.

The true relations of *Bronteus* are, as Prof. M'Coy perceived, with the *Ogyginæ*, but it is through forms which were not accessible to Beyrich or Emmerich. I shall not notice the fanciful and absurd division of the genus by Corda; but follow Beyrich, as Barrande has done, in arranging the species according to the number of segments combined in the pygidium. This is not usually a part of much consequence in classification; but by tracing the variation of the tail-piece in *Bronteus*, through *Bronteopsis* to *Barrandia*, the relations of the group to *Ogygia* are clearly seen. Otherwise we should really have had to look for its affinities to *Cheirurus*, as Beyrich has done. But the rostral shield and ungrooved pleuræ are as much characters of *Illænus* as they are of *Cheirurus*. The granulated eye is found, it is true, in *Æglina*; but it is very rare in the *Asaphidæ*. The shape and lobes of the glabella are much like those in *Barrandia*; and, as before said, the shortened tail-axis of the last genus points to the still shorter axis in *Bronteopsis*, and the almost obsolete one in *Bronteus*.

We may define the forms in this family as follows:

Broad oval, generally depressed, sometimes very convex, with nearly equal head and tail portions; lineated (rarely granulated) all over. Glabella distinct and wide above, with three unequal lateral lobes and a broad large forehead-lobe; a rostral shield; granular eyes; the facial suture ending on the posterior margin; ten grooveless pleuræ. The tail large, with greatly abbreviated axis and radiant pleuræ.

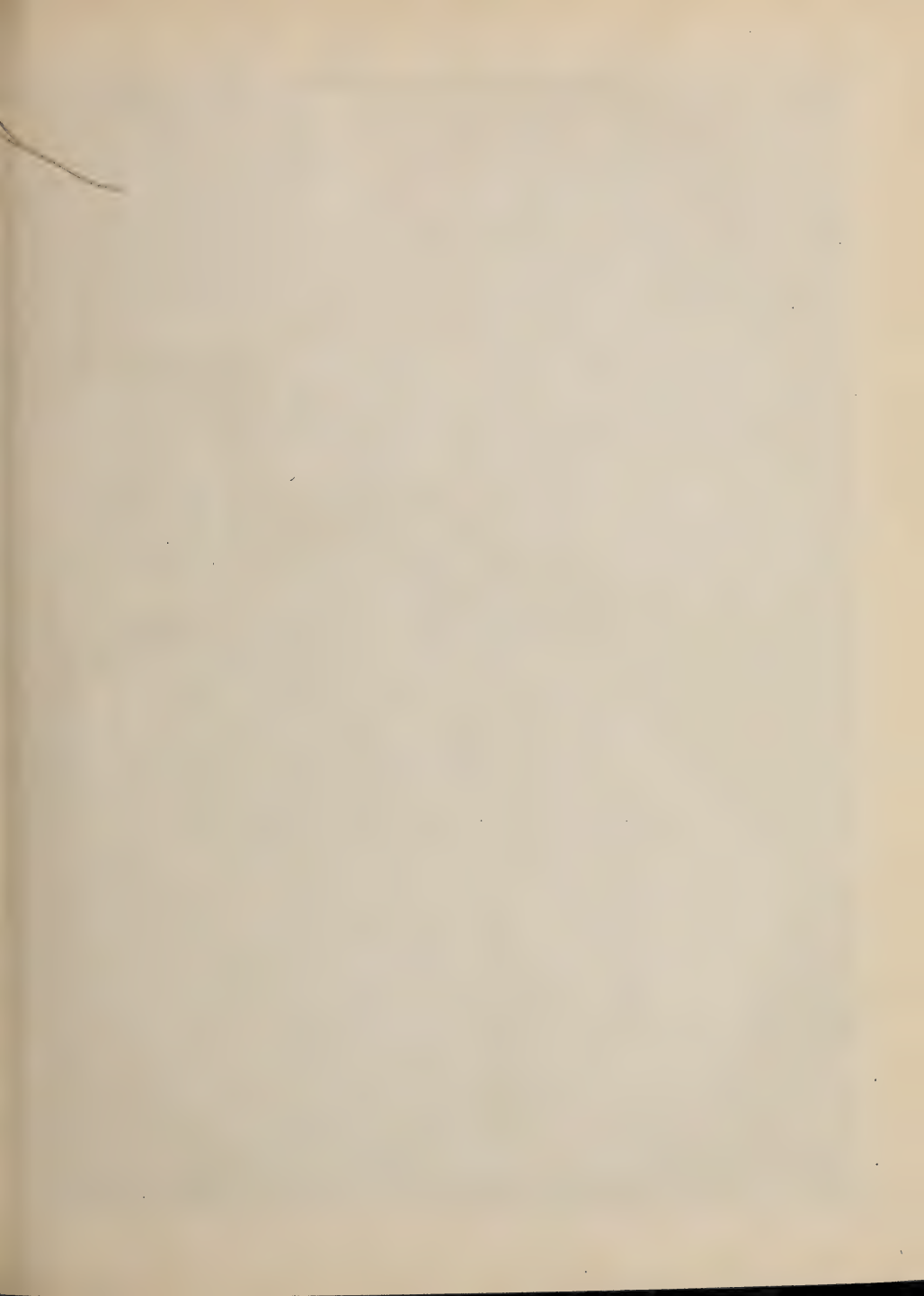


PLATE XXV*.

(To aid Plate XVII.)

ARENIG ROCKS (LOWEST SILURIAN).

- Figs. 1—4. *Ogygia peltata*, SALTER. All natural size. From the vertical black slates of Whitesand Bay, St. David's, Pembroke-shire. (See Pp. 133—135, and 177.)
1. " " Intaglio of young ♂ specimen. (Woodwardian Mus., Cambridge, case G*h*.)
2. " " Very perfectly preserved ♀ form, showing the place of the eye, facets of the pleuræ, and the short interlining furrows of the tail, which differ from *O. scutatrix*. (Same Museum.)
3. " " Wide labrum, broken at the tip. (Cabinet of the late H. Wyatt-Edgell, Esq.)
4. " " Full grown ♀ form (Woodwardian Museum, case G*h*.)
- Fig. 5. *Ogygia bullina*, SALTER. Same Locality and Museum. P. 178.

All these specimens were collected by H. Hicks, Esq., M.D., St. David's.



1-5 *Oxyura pellucida*

6-8 *Valonia*

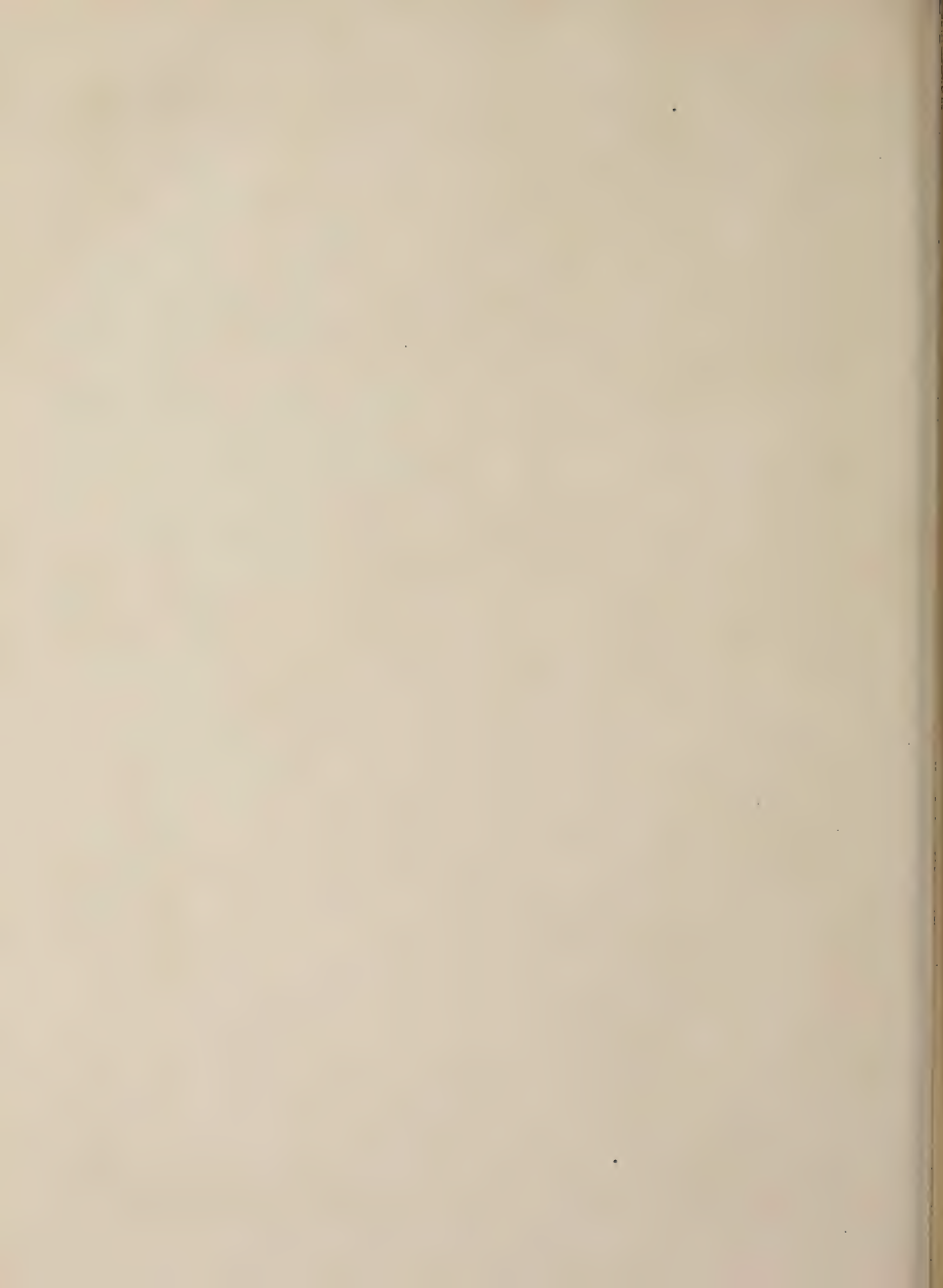
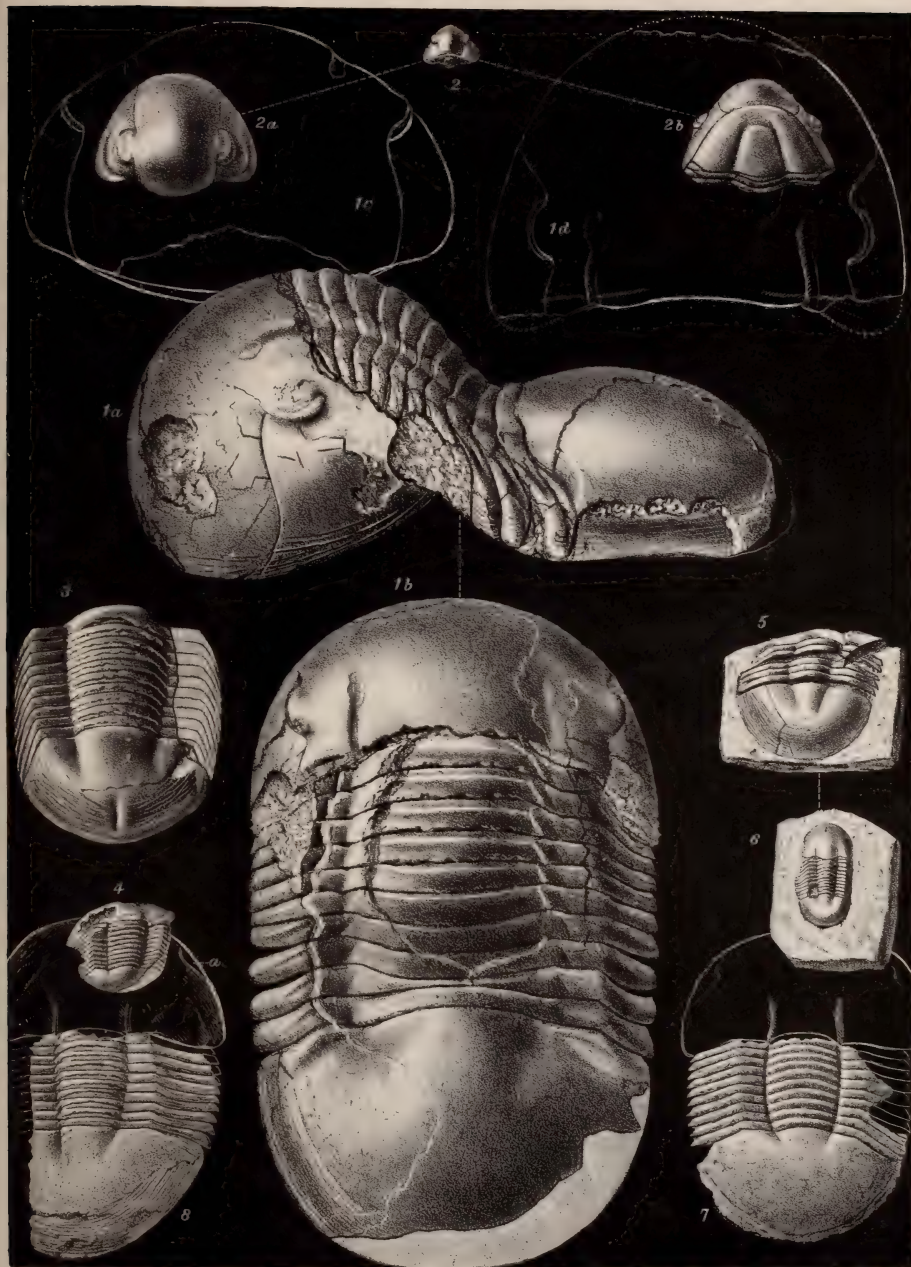




PLATE XXVI.

LOWER SILURIAN (LLANDEILO AND CARADOC).

- Fig. 1 *a, b.* *Illænus (Ill.) Murchisoni*, SALTER. Front and side views of a very fine specimen in Mr. J. E. Lee's collection; from Grug Quarry, Bird's Hill, Llandeilo; in Caradoc or Bala limestone. P. 201.
- 1 *c, 1 d.* ,, ,, Direct and front views of the head, same specimen.
- Fig. 2. *Illænus (Pandertia) Lewisii*, SALTER. Nat. size and magnified. Moelydd, Oswestry, in Caradoc rocks. (Cabinet of Rev. D. Phillips Lewis, of Guilsfield.) P. 183.
- Figs. 3, 4. *Illænus (Ill.) Portlockii*, SALTER. Caradoc schists of Desertcreat, Co. Tyrone. (Portlock's originals, Museum P. Geology.) P. 197.
- Figs. 5—8. *Illænus (Ectillænus) perovalis*, MURCHISON. Llandeilo rocks of Shropshire and South Wales, P. 211.
- 5, 6. ,, ,, ,, Specimens figured in the 'Silurian System.' (Museum of the Geol. Society.) From near Shelve.
7. ,, ,, ,, More fully grown specimen, without the head, which is restored in outline from fig. 8. Llanrian, near Abereiddy Bay, Pembrokeshire. (Mus. P. Geol.)
8. ,, ,, ,, Nearly perfect specimen, with head. We were compelled only to outline the head, as the plate was already finished ere this specimen was found.) At *a* the place of the eye is indicated. (Cabinets of Mr. Lightbody and Dr. H. Hicks.)



3 1/2 inches 1/2 1/2 1/2 1/2 1/2 1/2 1/2 1/2 1/2

1. *Phacops* *Marshalli* 2. *Phacops* 3. *Phacops* 4. *Phacops* 5. *Phacops* 6. *Phacops* 7. *Phacops* 8. *Phacops* 9. *Phacops*

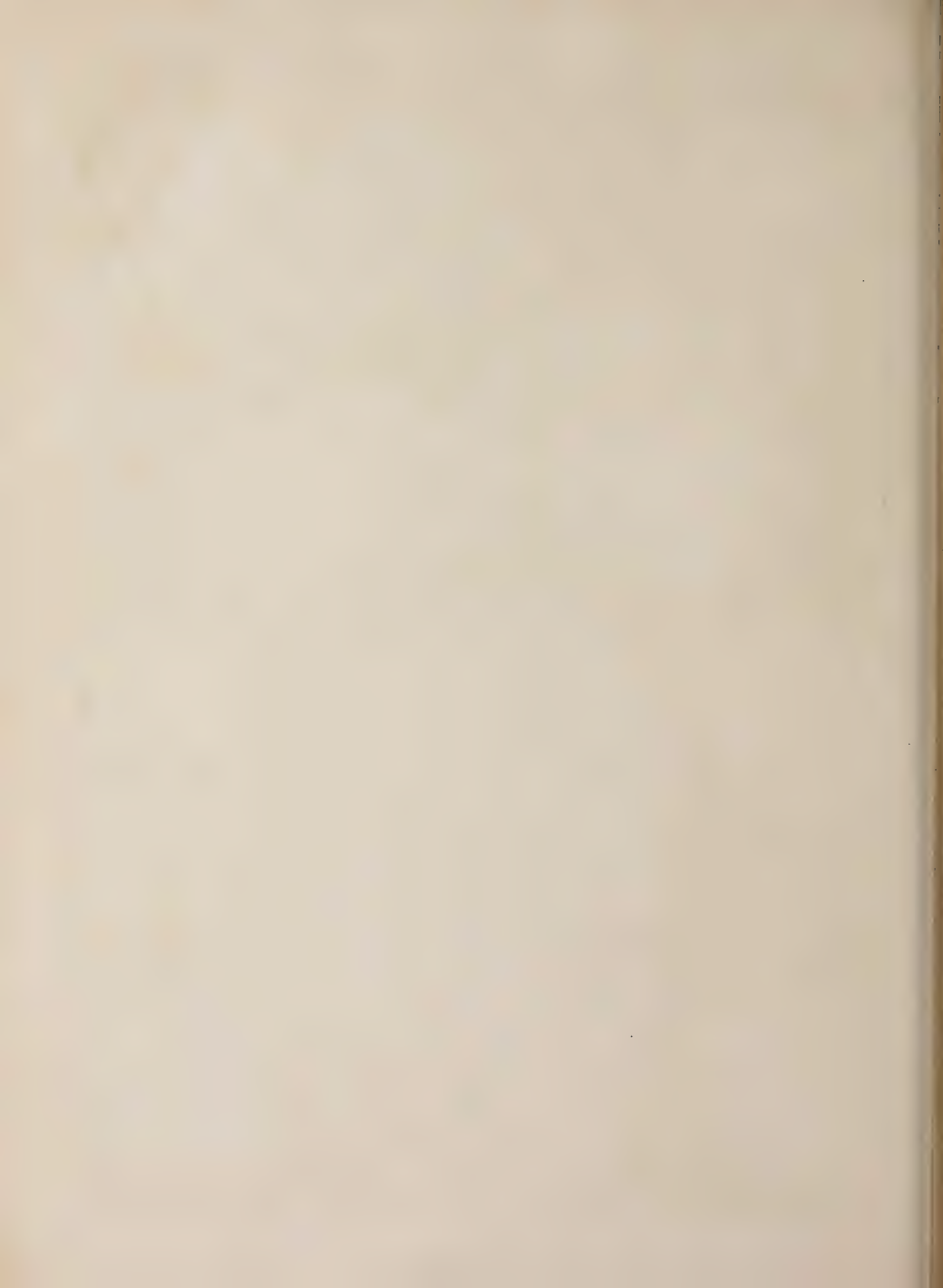
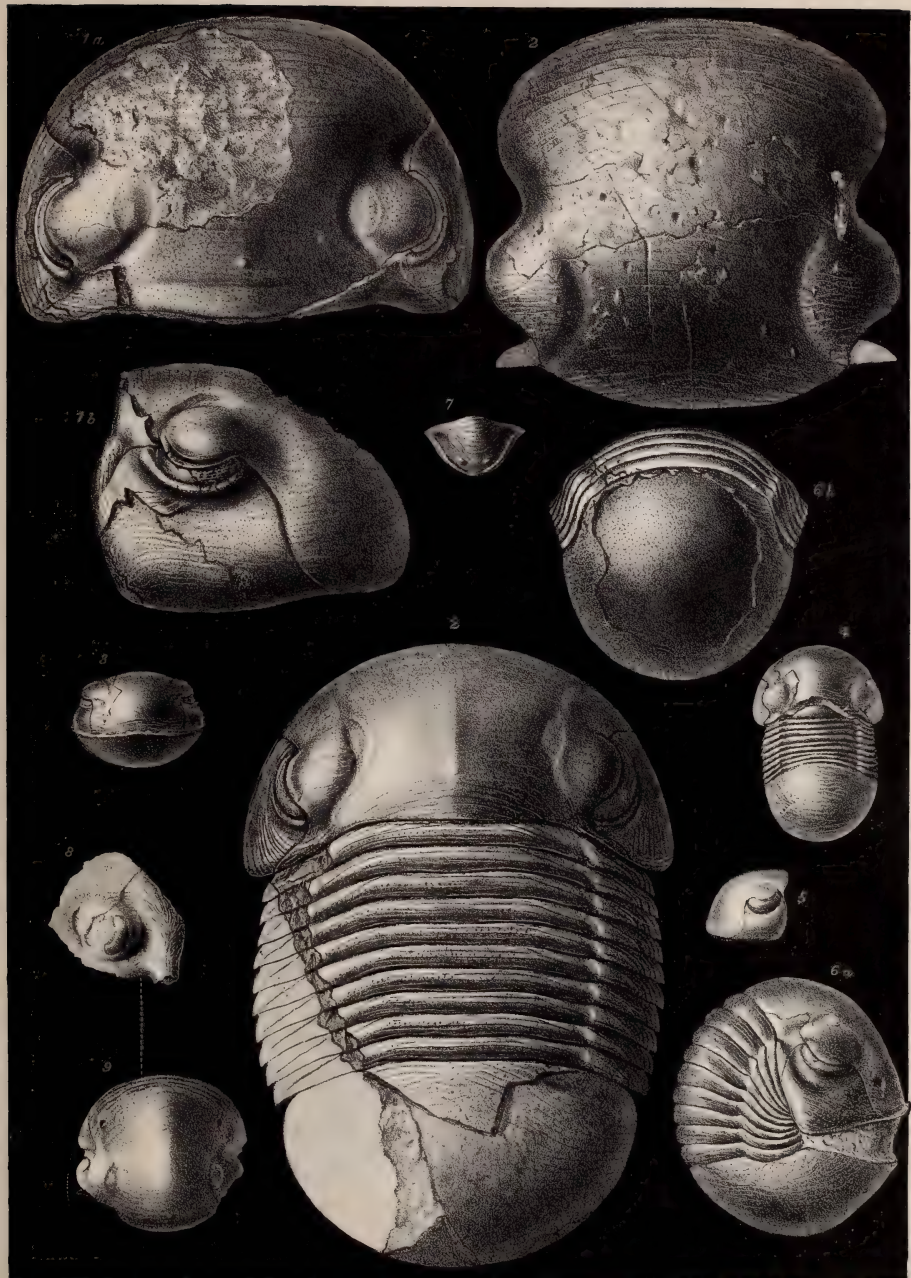




PLATE XXVII.

WOOLHOPE AND WENLOCK ROCKS (UPPER SILURIAN).

- | | | | | |
|---------------------------|--|---|---|---|
| Figs. 1—5. | <i>Illænus (Bumastus) Barriensis</i> , MURCHISON. | | | |
| 1 <i>a</i> , 1 <i>b</i> . | " | " | " | Direct and side views of the fine head figured in Decade 2, pl. iv, 'Mem. Geol. Survey.' Woolhope. (Mus. P. Geol.) It shows well the great glands (or muscle-spots?) over the eyes, and the strong sculpture, even on the cast. |
| | (Pp. 203—207.) | | | |
| 2, upper figure | " | " | " | Large head, wanting the free cheeks. Woolhope shales of Malvern Tunnel. (Dr. Grindrod's Collection.) |
| 2, lower figure | " | " | " | Miss Jukes' original specimen. From Barr, Staffordshire. An unequalled example, of which casts are in all museums. Woolhope limestone. |
| 3. | " | " | " | Young specimen, front view, to show flatness of head. (Dr. Grindrod's Collection.) Malvern Tunnel. |
| 4. | " | " | " | Younger still. Woolhope. (Mus. P. Geol.) |
| 5. | " | " | " | Side view of young head. (Dr. Grindrod.) Malvern Tunnel. |
| Figs. 6, 7. | <i>Illænus (Bumast.) insignis</i> , HALL (<i>Il. pomatia</i> on plate). | | | |
| 6. | " | " | " | Fig. 6 is Dr. Grindrod's exquisite specimen from Ledbury, Herefordshire. WENLOCK LIMESTONE. |
| | (P. 207.) | | | |
| 7. | " | " | " | Labrum, from Dudley. (Gray's Collection, British Museum.) |
| Figs. 8, 9. | <i>Illænus (Bumast.) carinatus</i> , SALTER. From the Wenlock limestone of Winnings Quarry, Malvern. (Presented to the Mus. P. Geol. by the late Rev. F. Dyson.) | | | |
| | (P. 209.) | | | |
| 8. | " | " | " | Free cheek, eye, and broken spinous head-angle. |
| 9. | " | " | " | Upper view of head, showing carinated form of same, and the axal puncta. |



15 *Illeus Barbieri*

67 *Lyonota*

89 *Lyonota*



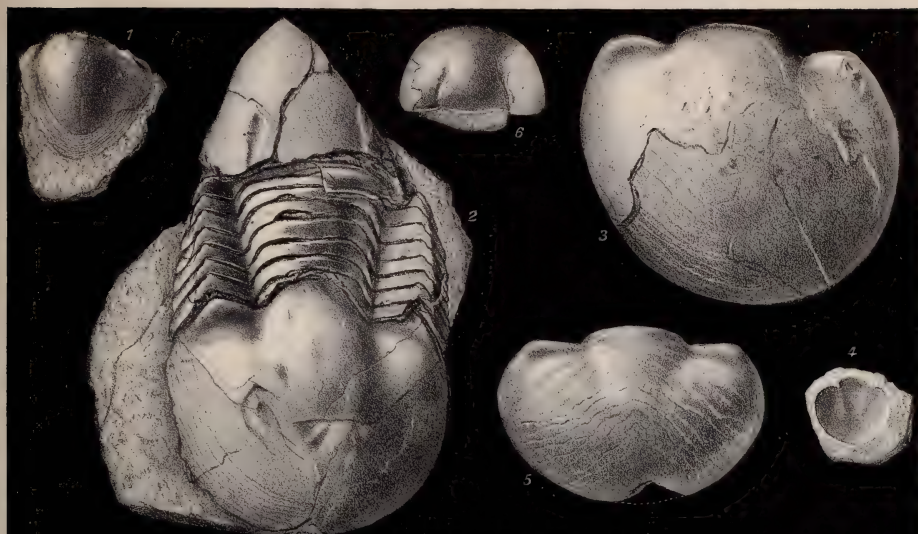
PLATE XXVIII.

MIDDLE SILURIAN (LLANDOVERY AND MAY HILL ROCKS).

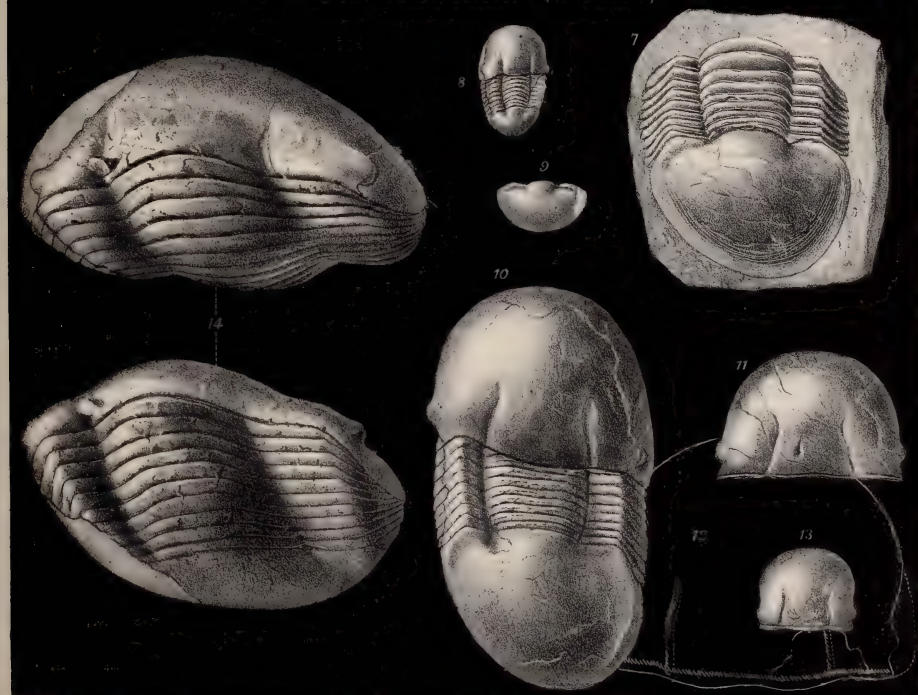
- Fig. 1. *Illænus (Bumastus) Maccallumi*, SALTER. Mullock, Girvan, Ayrshire. (Mus. P. Geol.) P. 210.
- Figs. 2—4. *Illænus (Dysplanus) Thomsoni*, SALTER. P. 188.
2. " " " Internal cast, the same figured by Murchison, 'Quart. Geol. Journ.' From Mullock, Girvan. (Mus. P. Geol., presented by Sir Roderick I. Murchison.)
3. " " " Tail of ditto. Same Locality and Museum.
4. " " " Obscure young specimen. Purple shales (Tarannon shale) of Onny River, Shropshire. (Mus. P. Geol.)
- Fig. 5. *Illænus (Dysplanus) æmulus*, SALTER. May Hill sandstone of Norbury. (Mus. P. Geol.) P. 187.
- Fig. 6. *Illænus (Dysplanus) Bowmanni*, SALTER. Same Locality and Museum as the last. P. 185.

LOWER SILURIAN (CARADOC).

- Figs. 7—13. *Illænus (Dysplanus) Bowmanni*, SALTER. P. 185.
7. " " " Half-grown. Desertcreat, Tyrone. (Mus. P. Geol.) Portlock's original.
8. " " " Young. Same Locality and Museum.
9. " " " Young tail, very short. Shoals Hook, near Haverfordwest. (Mus. P. Geol.)
10. " " " Half-grown fine specimen from the Bala slates of Llanwddyn, Montgomeryshire. (Woodwardian Museum; M'Coy's figured specimen of '*Il. centrotus*.')
11. " " " Variety, with longer and more connivent head-furrows. (Mus. P. Geol.)
12. " " " Outline of large head. Shoals Hook, Pembrokeshire. (Mus. P. Geol.)
13. " " " Young head. (Old Red ? conglomerates, derived from the) Coniston or Bala limestone, Troutbeck. The species shows the attachment of the lower (mandibular?) muscles. (Mus. Wyatt-Edgell.)
- Fig. 14. *Illænus (Ill.) Baillyi*, SALTER. Dunabratin Head, Waterford. In limestone. (Mus. Irish Survey.) P. 192.



LOWER SILURIAN (Caradoc)



Life casts, & A. G. S. coll.

W. G. S. coll.

1. *Elonic MacCallum*, 2. *A. Thomson*, 3. *Elonic*, 4. *Elonic*, 5. *Elonic*, 6. *Elonic*, 7. *Elonic*, 8. *Elonic*, 9. *Elonic*, 10. *Elonic*, 11. *Elonic*, 12. *Elonic*, 13. *Elonic*, 14. *Elonic*

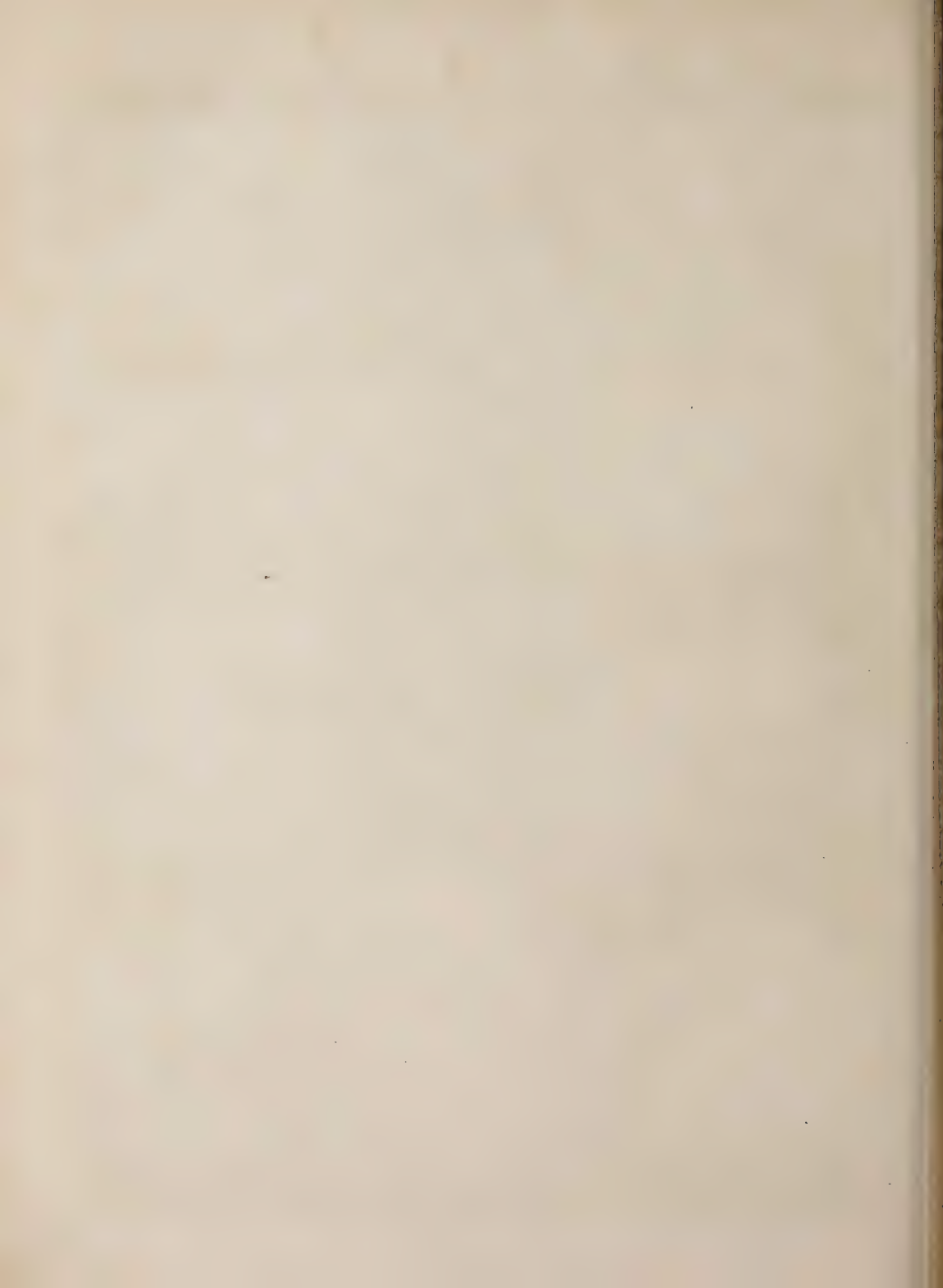




PLATE XXIX.

LOWER SILURIAN (CARADOC).

- Fig. 1. *Stygina? Musheni*, SALTER. Boulder (probably of Caradoc), from the Drift, Buildwas, Shropshire. (Brit. Mus.) (P. 174.)
- Figs. 2—6. *Illænus (Ill.) Rosenbergi*, EICHWALD? From the Coniston or Bala limestone of Coniston and Troutbeck. (Except fig. 5, which is Mr. Wyatt-Edgell's specimen, all are in the Woodwardian Museum.) Figs. 2, 3, 4, are figured in Prof. Sedgwick's 'Synopsis,' and show the sculpture well.
- Figs. 7—9. *Ill. (Illænus?) ocularis*, SALTER. 7, Side view of head; 8, head, nat. size; 8 *a*, magnified; 8 *b*, sculpture enlarged. CARADOC or BALA limestone, Chair of Kildare. (Mus. P. Geol.) (P. 198.)
9. " " ? A larger fragment of the side of the head, probably the same species. Same Locality and Museum.
- Figs. 10—16. *Ill. (Illænus) Davisii*, SALTER. CARADOC or BALA limestone. (P. 194.)
10. " " The finest known. Figured in the Woodwardian 'Synopsis' by M'Coy and Salter. (Woodw. Mus., Cambridge.)
11. " " Ordinary form at Rhiwlas, Bala. (Mus. P. Geol.)
- 12, 13. " " Restored figure, from Decade 2, Geol. Survey.
14. " " Epistome or rostral shield. (Mus. P. Geol.)
15. " " Side view. Same locality and cabinet.
16. " " Young tail, from Mr. Wyatt-Edgell's cabinet, showing a nearly complete axis.

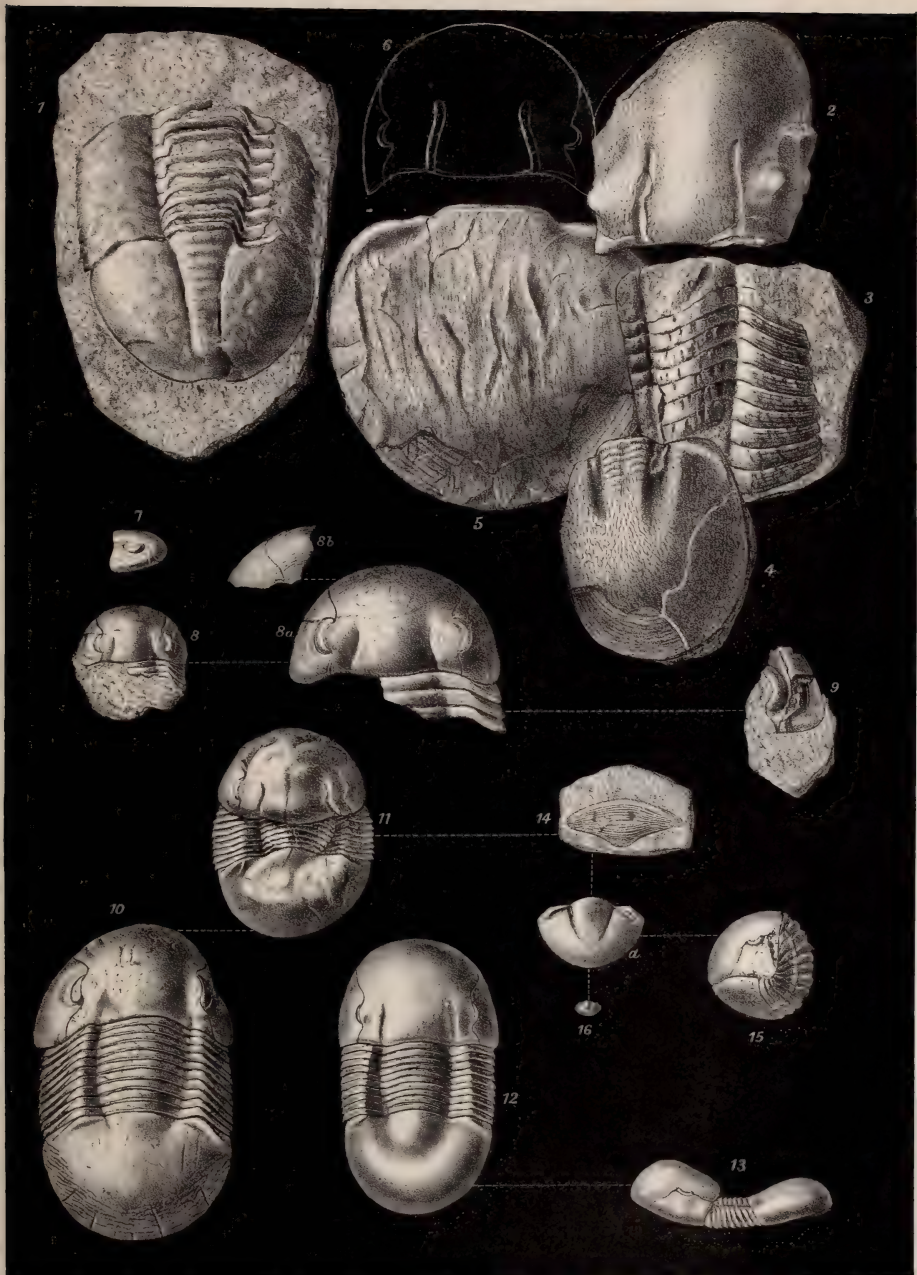






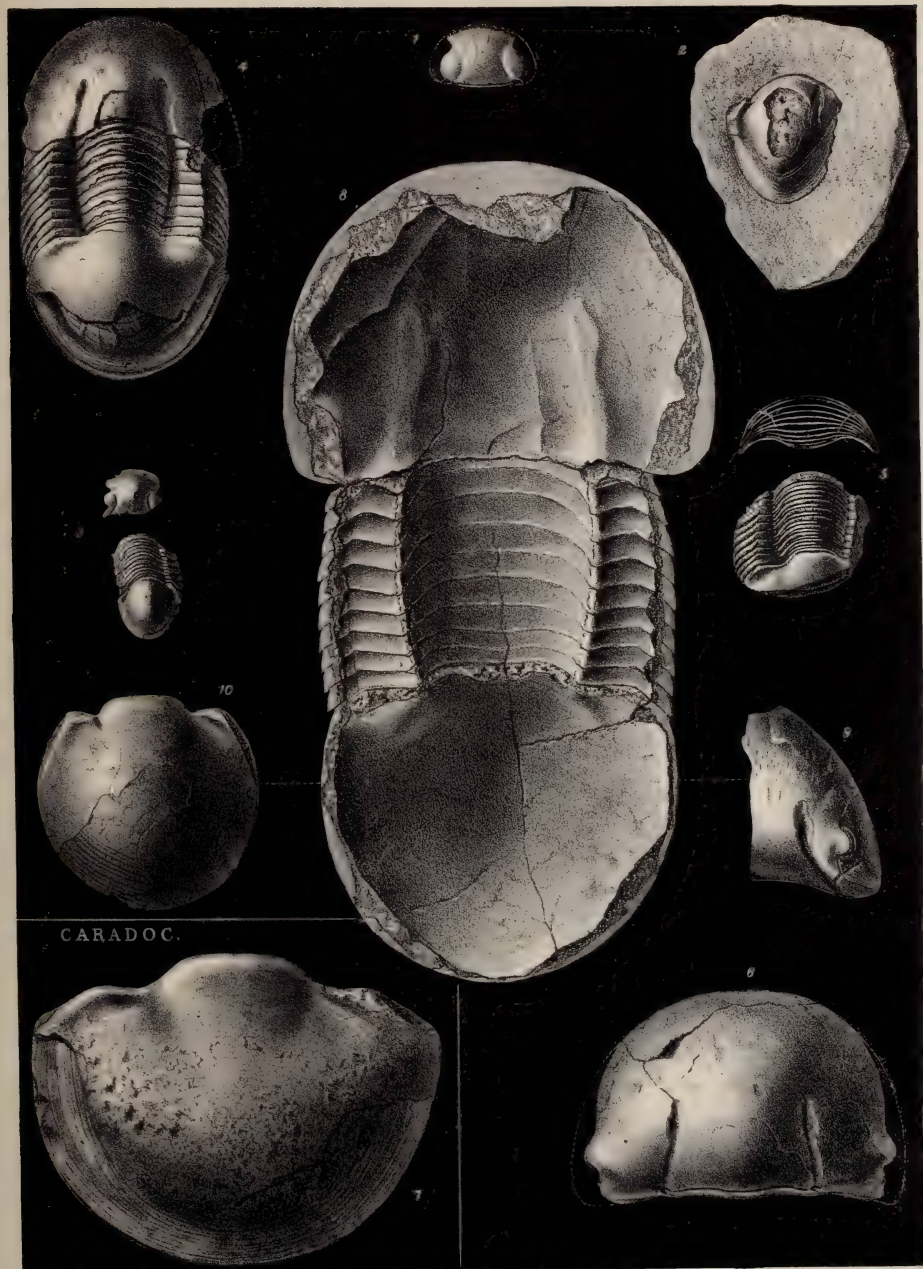
PLATE XXX.

LLANDOVERY ROCKS (MIDDLE SILURIAN).

- Fig. 1. *Illæus (Bumastus) Barriensis*, MURCHISON. A solitary specimen from the Purple (Tarannon) shales of the Onny River, Shropshire. (Mr. Wyatt-Edgell's Cabinet.) P. 203.
- Figs. 2, 3. *Ill. (Bumastus) Maccallumi*, SALTER. From the Llandovery (not the May Hill) rocks of Girvan, Ayrshire. (See also Pl. XXVIII, fig. 1.) Fig. 2, tail, full-grown; 3, young specimen, dismembered. The free cheeks are yet wanting; possibly they are spinose. (Mus. Prof. Wyville Thomson.) P. 210.
- Figs. 4, 5. *Ill. (Dysplanus) newilis*, SALTER. Llandovery rocks of Drummuck, near Girvan, Ayrshire. (Prof. Wyville Thomson's cabinet.) Figs. 4 and 5 show the broad epistome, unlike that of *Il. Bowmanni*. (Mr. Wyatt-Edgell's Cabinet.) Fig. 4 shows the fascia, which is much bent in this species. P. 190.
- Fig. 6. *Ill. (Dysplanus) Bowmanni*, SALTER. Llandovery mudstone of Mullock, Girvan, Ayr. (Cabinet of Prof. Wyville Thomson.) P. 185.
- Figs. 8, 10. *Ill. (Dysplanus) Thomsoni*, SALTER. Llandovery rock. P. 188.
8. " " Large intaglio in yellow sandstone, from Mullock, near Girvan, Ayrshire. (Prof. Wyville Thomson's cabinet.)
9. " " Side of head, showing eye and free cheek (very rarely found). The Gas Works, Haverfordwest. (Mr. Wyatt-Edgell's Cabinet.)
10. " " Tail, from Mullock, Girvan, Ayrshire; showing truncate angles. (Woodw. Mus.)

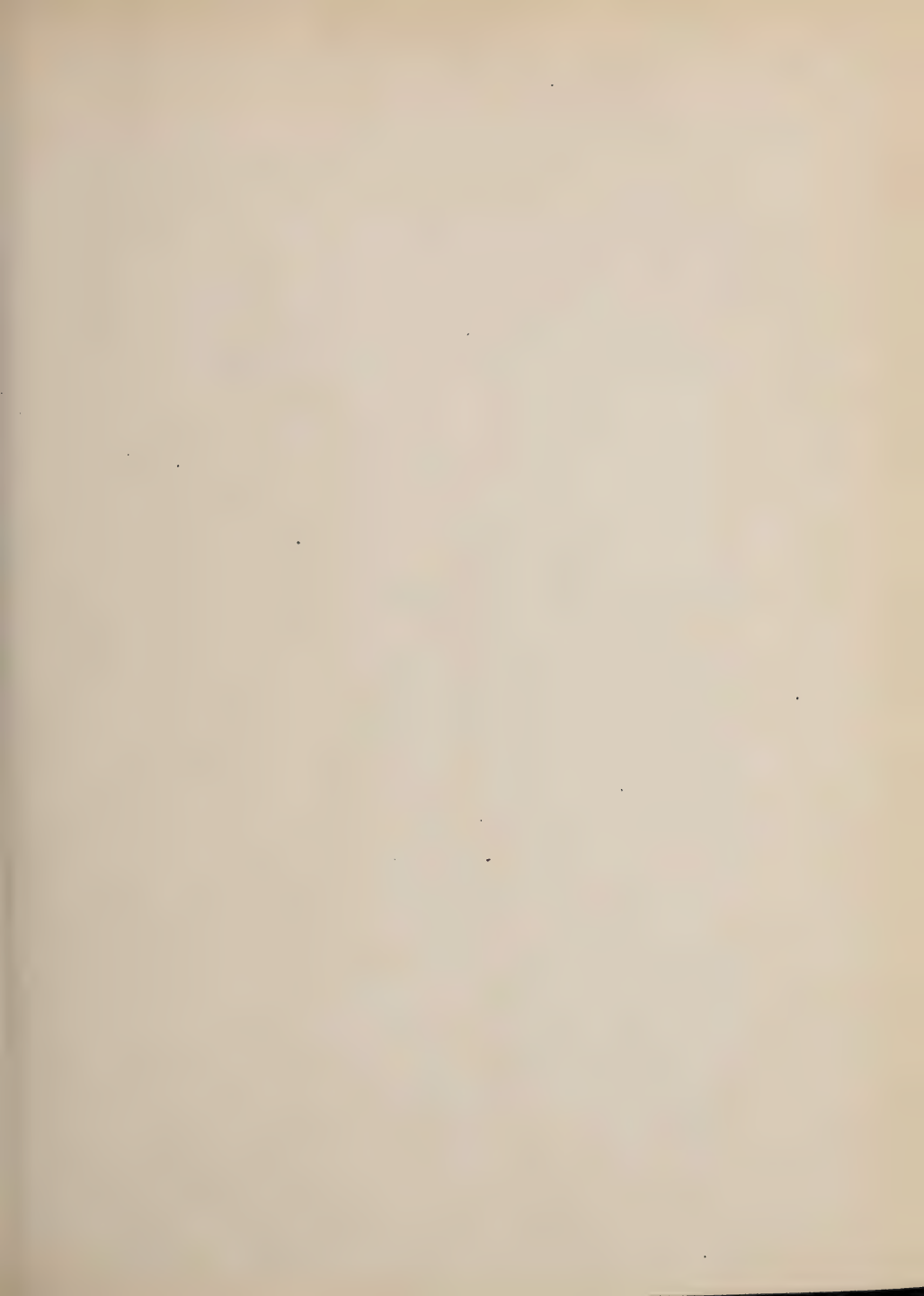
LOWER SILURIAN.

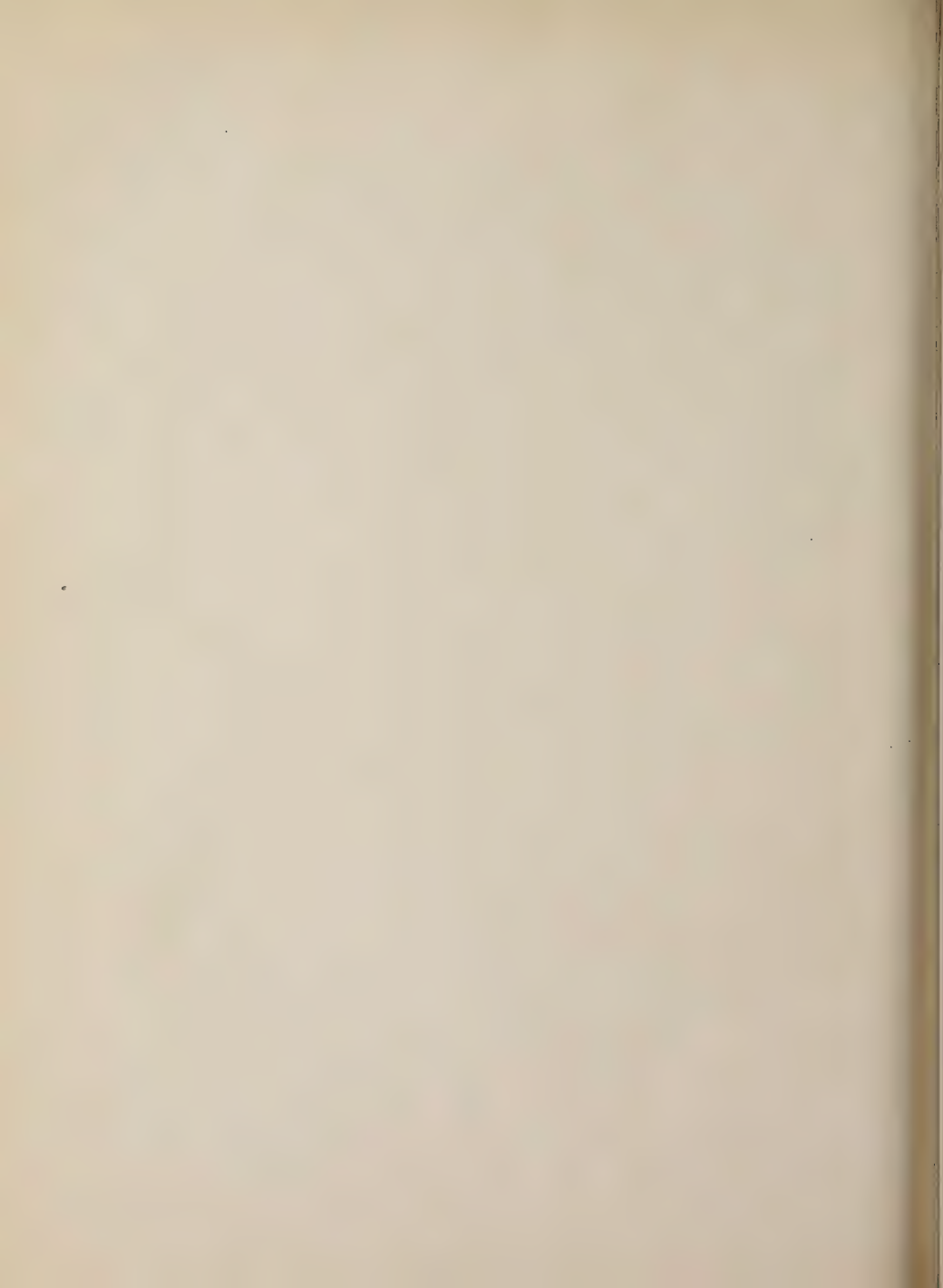
- Fig. 7. *Ill. (Illæus) Murchisoni*, SALTER. CARADOC limestone of Chair of Kildare, Ireland. (Cabinet of Mr. Wyatt-Edgell.) This should have been in Pl. XXVI. P. 201.

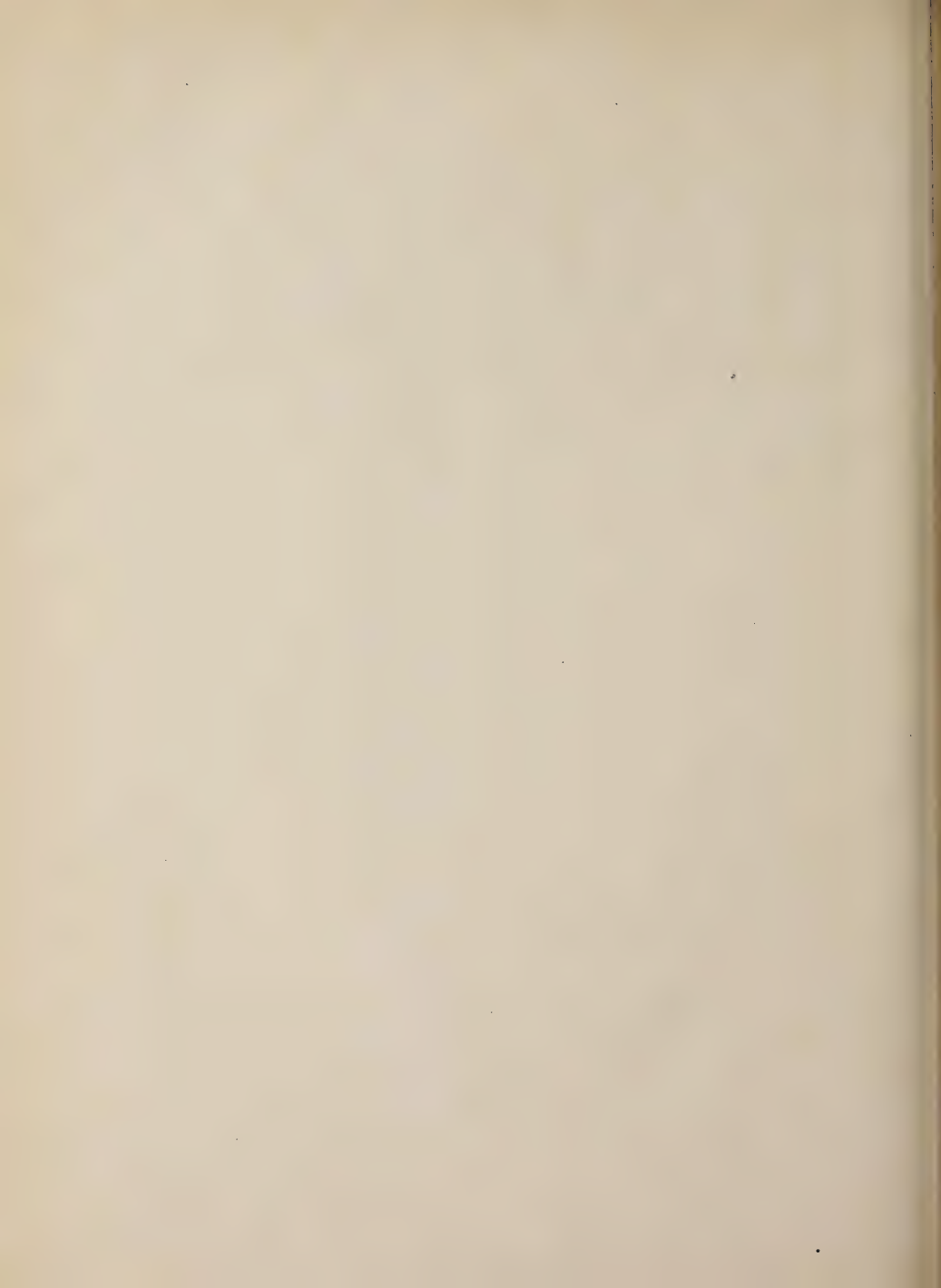


CARADOC.

1 *Illymus barroensis*2 & 3 *M. Callum*4 *T. Lucie*5 *P. pycnanota*6 *Murchisoni*8 & 10 *T. Thomsoni*







THE

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MDCCCLXVII.



A MONOGRAPH

OF THE

BRITISH FOSSIL BRACHIOPODA.

PART VII. NO. II.

CONTAINING

PAGES 89—168; PLATES XIII—XXII.

THE SILURIAN BRACHIOPODA.

BY

THOMAS DAVIDSON, F.R.S., F.G.S.,

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IMPERIAL MINERALOGICAL SOCIETY OF ST. PETERSBURG; ROYAL ACADEMIES OF BELGIUM AND OF BAVARIA;
SOCIÉTÉ ROYALE HOLLANDAISE DES SCIENCES, HARLEM; ROYAL SOCIETY OF LIÈGE; ACADEMY OF
ST. LOUIS; AMERICAN PHILOSOPHICAL SOCIETY, PHILADELPHIA; ZOOLOGICAL SOCIETY OF
VIENNA; PALÆONTOGRAPHICAL SOCIETY OF BELGIUM; HON. MEMBER OF THE
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1867.

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SPIRIFERA PLICATELLA, var. *GLOBOSA*, *Salter*. Pl. IX, figs. 7, 8.

SPIRIFER PLICATELLUS, var. *GLOBOSUS*, *Salter*. Mem. Geol. Surv., vol. ii, part i, p. 382. 1848.

SPIRIFERA PLICATELLA, var. *GLOBOSA*, *Lindström*. Proceed. Roy. Acad. Sc. Stockholm, 1860, p. 158.

The shell of this variety is, according to Mr. Salter, "about as wide, or a little wider than long; hinge-line very short; beaks approximate; furrows none; very gibbous;" it is the variety easily connected with *Spirifer radiatus*, Sow. Indeed, there appears to be little by which it can be distinguished from the true *Spirifera radiata*, except the greater convexity or gibbosity of its valves and its finer striation. Two specimens measured—

Length 20, breadth 26, depth 15 lines.

„ 15, „ 17, „ 13 „

Spirifera Marklini, de Vern., is easily distinguishable from *Sp. globosa* by its less transverse shape, and by its great depth and square-like appearance.

This variety is not rare in the Wenlock Limestone at Dudley; and it occurs also in the Island of Gothland.¹

SPIRIFERA BIJUGOSA, *M'Coy*. Pl. X, figs. 1—3.

SPIRIFER BIJUGOSUS, *M'Coy*. Synopsis Sil. Foss. Ireland, p. 36, pl. iii, fig. 23, 1846.

— — *Salter*. Explanation of Sheets 160, 161, 171, and 172, Geol. Surv. Ireland, p. 13, 1863.

Spec. Char. Rotundato-quadrate, wider than long, valves more or less gibbous; hinge-line as long as the width of the shell. Dorsal valve rather less deep than the opposite one; mesial fold moderately wide; smooth, and divided along the middle by a deep hollow groove; the remaining portions of the valve being covered with from twenty to twenty-four obtusely angular, simple ribs, the whole crossed by numerous concentric lines of growth. In the ventral valve the sinus is wide and concave, and extends from the extremity of the beak to the front; while the lateral portions of the valves are covered with ribs, as in the opposite valve; beak incurved, area about a couple of lines wide, fissure triangular, and partly arched over by a pseudo-deltidium. A large specimen measured—

Length 12, width 14 lines.

¹ Herr Lindström informs me that he has seen *Spirifera plicatella* from the Upper Silurian rocks in the neighbourhood of Christiania in Norway, accompanied by the following species—*Spirifera elevata*, *Meristella tumida*, *Atrypa reticularis*, *At. imbricata*, *Pentamerus oblongus*, *P. linguiferus*, *Rhynchonella cuneata*, *Rh. diodonta*, *Rh. nucula*, *Rh. spherica*, *Rh. Wilsoni*, *Orthis canaliculata*, *O. hybrida*, *O. biforata*, *Strophomena rhomboidalis*, *St. pecten*, *Leptæna transversalis*, and *Chonetes striatella*:—a series which must, says Mr. Salter, "represent our May Hill Sandstone."

Obs. Prof. M'Coy informs us that "this species is remarkable for having its mesial ridge (fold) divided in two by a mesial sulcus, in which it agrees with *Spirifer bifidus*, Roemer, but from which it differs in the lateral ribs being less numerous and not branched, as in that species. The mesial hollow (sinus of ventral valve) is somewhat simple, and sometimes has a slender mesial ridge. In finely preserved examples the striæ of growth are regular and prominent." I may likewise observe, that *Spirifera bijugosa* bears some resemblance in shape and size to *Spirifer bijugatus*, Von Buch; but this last seems to possess a smaller number of ribs; and its sinus and fold appear also to differ somewhat in shape from that of the shell under description. Prof. M'Coy figures the dorsal valve only; and, although I have seen several specimens of both valves, no example I have met with was completely perfect. The species is not recorded in 'Siluria,' nor in Morris's 'Catalogue of British Fossils.'

Position and Locality.—Prof. M'Coy states that *Sp. bijugosa* is very abundant in the shales of Doonquin, Dingle, County Kerry, and very common in the slates of Ferriter's Cove, Dingle. According to the Geological Surveyors, the rocks at Dunquin,¹ to a little north of Clogher Head, are equivalents of the Ludlow beds. The strata at Ferriter's Cove, joining it to the north, and on the coast between Dunquin and Clogher Head, are coloured as 'Wenlock.' The Wenlock rocks of this district (Dingle) are described on the label of the fossil cases of the Museum of the Geological Survey in Dublin as "a slaty and very fossiliferous series, with much interstratified trap." *Sp. bijugosa* occurs on the north shore of Ferriter's Cove in Wenlock rocks, with (according to Mr. Salter) "*Athyris tumida*, *Atrypa reticularis*, *Chonetes lata*, *Leptæna transversalis*, *Orthis calligramma*, *O. elegantula*, *Rhynchonella borealis*, *Rh. rotunda*, *Strophomena compressa*, *St. euglypha*, *St. funiculata*, *St. imbrex*, and *St. pecten*," as well as with many species of Corals, Conchifera, Gasteropoda, Annelida, and Crustacea, peculiar to beds of the Wenlock age. It is further stated by Mr. Salter, who surveyed the ground (p. 13 of the same 'Explanation'), that *Sp. bijugosa* occurs also in the Croaghmarhin or Aymestry beds in the same district, which contain abundance of *Pentamerus Knightii*, *P. galeatus*, *Rhynchonella Wilsoni*, and other fossils, such as are found in the Aymestry rocks of Siluria

¹ This locality is spelt *Dunquin* on the one-inch map of the Ordnance Survey, also in the 'Explanation of Sheets 160, 161, 171, and 172, of the Geological Survey of Ireland, 1863,' where will be found an excellent description of the beds and fossils by Messrs. G. V. Dunoyer and J. W. Salter. Mr. Bailly informs me that Dunquin is a parish of some extent on the coast, joining Dunurlin, which includes Ferriter's Cove; there is also a village of Dunquin, south of Clogher Head. He tells me that Wenlock rocks, with interstratified igneous rocks, much faulted, occur on the coast north and south of Ferriter's Cove, between that and Clogher Head, as may be seen on the one-inch map, Sheet 171; also, that Ludlow rocks occur in the district; but that after having carefully searched the registers of fossils of the Irish Geological Survey, he could not find *Sp. bijugosa* in any locality of the Ludlow Rocks, but always in those coloured as Wenlock, and abundant at Ferriter's Cove, that is, in the parish of Dunurlin, and also in what are considered to be the same rocks on the coast south of Clogher Head, in the parish of Dunquin.

(Shropshire, &c.); and the section of this west coast of Ireland is perfectly clear. *Spirifera bijugosa* occurs chiefly in the condition of external and internal casts, and has not been hitherto found in England, Wales, or Scotland.

SPIRIFERA SULCATA, *Hisinger*. Pl. X, figs. 4—6.

ANOMIA CRISPA, *Linné*. Syst. Nat., 12th edit. p. 1152, 1767; and Mus. Tessin., p. 90, tab. v, fig. 7, 1753.

DELTHYRIS SULCATA, *Hisinger*. Anteckn. Physik. och Geognosi, p. 119, tab. iii, fig. 2, 1831.

— — *Ibid.* Lethæa Suecica, p. 73, tab. xxi, fig. 6, a, b, c, 1837.

SPIRIFER SULCATUS, *Davidson*. Bull. Soc. Géol. France, 2nd series, vol. v, pl. iii, fig. 41, 1848.

— — *De Verneuil*. Ibid., p. 347, 1848.

SPIRIFERA SULCATA, *Lindström*. Proceed. Roy. Acad. Sc. Stockholm, p. 359, 1860.

Spec. Char. Transversely subrhomboidal; hinge-line much longer than the width of the shell; cardinal angles pointed and extended; while, not uncommonly, one wing exceeds the other in length. Dorsal valve much less convex than the opposite one, bearing three or four principal ribs, of which the central one is both the largest and most elevated, the remaining lateral space being either smooth, or provided with one or two smaller or rudimentary ribs; the three or five principal costæ thus occupying either half or two-thirds of the surface of the valve. Ventral valve much deeper than the dorsal, with two or three ribs on each side of the sinus, which last is as broad as the width of the mesial rib or fold in the opposite valve; surface of both valves crossed by numerous concentric projecting laminæ, which overlap each other to a greater or lesser extent. Besides these, the surface is covered with a delicate network of small minute longitudinal and transverse striæ, visible only by the assistance of a magnifying glass. Beak slightly incurved; area rather wide, triangular, and divided in the middle by a fissure; deltidium composed of two triangular plates, which rise abruptly from the lateral margins of the fissure with their broadest extremities near the umbone of the dorsal valve, thus leaving only a narrow oval aperture in the middle; with age, this opening becomes more and more diminished in extent. Two specimens measured—

Length 6, width 10, depth 4 lines,

„ 4, „ 5, „ 3 „

but the shell is usually much smaller. It is a smaller species than *Sp. crispa*.

Obs. It is sometimes difficult to distinguish certain varieties of *Spirifera sulcata*, *Sp. crispa*, and *Sp. elevata*, the last two of which especially pass one into the other to a perplexing extent; nevertheless, when well shaped and full grown, they present recognisable distinctions; and palæontologists generally have considered it desirable that

they should be described under separate heads. Such also is the opinion of my distinguished friend Herr Lindström, who has devoted very great care and attention to the study of these species. Nevertheless, the question still demands further consideration.

Much difficulty has also been experienced by palæontologists, with reference to the correct determination of these shells; and great confusion has arisen from the uncertainty they have felt as to which form was intended by Linné as the type of his *Anomia crisper*. It must, however, be remembered, that at p. 1152 of the 12th edition of the 'Systema Naturæ' (1767), Linné has referred to the description and figure published in p. 90, tab. v, fig. 7, of the 'Musæum Tessinianum' (1753),¹ for the source whence his *Anomia crisper* was derived, and a reference to that figure, which we have reproduced in our

¹ 8. *ANOMIA angulis lateralibus dilatatis dentibus alternis*, tab. v, fig. 7.

Testa angulis utrinque dilatatis et dentibus alternis.

Valvula superior in medio longitudinaliter sulcis quatuor elevatis: ad latera vero sulco uno alterove.

Valvula inferior medio elongata et adscendens apice, qui etiam, uti latera, sulcis duobus elevatis notatur.

The original specimens described in the 'Musæum Tessinianum' are, I am told, preserved in the Museum of the University of Copenhagen.

In vol. i, part 2, of the 'Systema Naturæ,' edit. 12, is written:

"*Anomia crisper*, 232. A. testa dilatato-triangulari plicata sulcis rugosis: media latiore.

"Mus. Tessin., tab. v, fig. 7.

"List. Angl., t. 9, fig. 56.

"Habitat . . . fossilis.

"Testa fere lunata, sed natum superior prominens sulci 5—6, rugis arcuatis transversis. Latera testæ submucronata."

It would not be fair to expect that at a period when the science of palæontology was just about to spring into existence, the early observers, such as Linné, Lister, Plott, Fabius Columna, Bourguet, Bruguière, Davila, Hupsch, Walch, Klein, Knorr, Rumphius, Volkman, Ritter, Baumer, Andræ, Morton, and many others whose names we might mention, and who wrote previous to the present century, should have been very accurate in their investigations, comparisons, identifications, or illustrations; for experience and exactness, the fruit of immense labour acquired step by step, must necessarily have been exceedingly limited at those early periods; still it is sometimes necessary, when doubt is felt as to the type intended by any of these authors, to look carefully at their descriptions, however quaint they may be, and to the references to figures they may append. Now, in the case of *Anomia crisper*, Linné refers us also to Lister for a figure of his shell (t. ix, fig. 56), but a glance at Lister's description (which we here append for the sake of illustration) will at once convince the merest tyro in our science that the shell represented in the 'Musæum Tessinianum,' and that in the 'Historia Animalium Angliæ,' cannot belong to the same species. In fact, the first represents a small Silurian Spirifer; while the second illustrates a much larger and differently shaped Carboniferous species which Lister informs us he found in Lime-rocks, at Stock, in Craven, as his Latin description explains:

"LISTER. 'Historiæ Animalium Angliæ,' &c., 1678.

"*Pectunculites anomius*, cui insignis quedam lacuna per medium dorsum recta procedit, p. 247, t. 9. f. 56.

[13. Tab. iii, 6. Tab. iv, v, Plott.]

Pl. X, fig. 12, A, B, may, perhaps, oblige us to conclude that Linné had in view a shell similar to the one subsequently named *Delthyris sulcata* by Hisinger; and this is admitted by the last-named author himself, who at p. 119 of his 'Anteckningar' (vol. v, 1831), informs us that the description given by Linné of his *Anomia crispa* quite agrees with the one given by himself of *Delthyris sulcata*; but that, as Dalman (it was, indeed, Hisinger himself, who did so before) had adopted a different shell under the name of *crispa*, which had not the larger median rib (?),¹ he has been obliged to give to the Linnæan species the new name of *sulcata*. If we examine the Linnæan figure of *Anomia crispa*, though badly drawn, we find that it represents a *Spirifera* with extended pointed cardinal angles, and three principal ribs in the dorsal valve, as we so commonly find to be the case with Swedish and British specimens of the shell under description; while the form subsequently referred to, *A. crispa* (Linn.), by Hisinger, Dalman, and subsequent authors, has its hinge-line shorter than the width of the shell, and its cardinal angles obtusely rounded. At page 128 of Hanley's 'Ipsa Linnæi Conchylia' (1855), Mr. Sharpe states that he could not "find a specimen in the Linnæan Cabinet to which the whole of the Linnæan description would apply; but that, since the Swedes (Wahlenberg, Nilsson, Hisinger) have handed down so many of the fossil species of our

(Plott gives no figure of this Spirifer; Lister refers to plates of Plott containing similar figures.)

"*Descriptio.* Hic lapis modicæ magnitudinis est; à latere ad latus ferè sesquidigitum explet; à vertice ad imum ambitum uncialis est. In dorsum modicè elatus.

"Medium dorsum profundior quædam lacuna rectè dividit; item ad imam illam lacunam ipse margo labri cujusdam instar paulo productior est. Reliquæ etiam striæ, amplæ, et torosæ.

"Ipse vertex ex altera parte paulo angustior et aliquantulum rostratus est; adeoque inter anomios ponendus est.

"Juxta cervices quasi humeri acuti eminent, ut in Pectinitis, si aures iis demptæ essent.

"Insignem crassitudinem horum lapidum, quâ parte testas referunt, satî mirari nequeo; certè multum supra modum omnium viventium Concharum. At his eadem ferè materia, quæ reliquis plerisque figuratis corporibus, in iisdem rupibus inventis ut Trochitis, de quibus alibi ('Philosoph. Transact. Dict. d. Oldenburgh,' No. 100, p. 6181), fuse tractavi, sc. è cujusdam floris natûra.

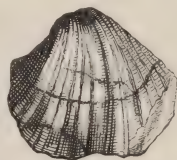
"*Locus.* Ex his innumeros in saxo calcario sublivido plumbiferoque, quodam oppidulo regionis Craven, Stock dicto, inveni. Ubi omnes, quantum vidi, singulares fuerunt.

"At ex agro Staffordiensi bifores cinereo habemus; et ex ipsis submarinis rupibus juxta Scarborough bifores solidos, pellucidos, et quasi siliceos ipse exemi.

"Imò unum apud me servo ex silice propriè sic dicto albo et non pellucido, quod experimentum de chalybe captum abundè testatur.

"*N.B.* Reliquis omnibus, exceptis iis, qui juxta Stock inventi sunt, isti humeri angulosi deesse videntur, imò aliquibus et labrum et lacuna haud ita conspicua sunt; easdem varietates plurimas in crystallis quibuscunque observare licet."

¹ I am at a loss to understand what Hisinger means, by stating that his *Delthyris crispa* has not the larger median rib; for it exists in all the Swedish specimens I have seen.



author in an unbroken line of tradition, confirmed in so many cases by the types in Linné's collection, the *Spirifer* recognised by them as the *Anomia crispa* may be accepted with confidence." I must also hasten to admit that when in 1847 Messrs. Salter and Sharpe, with myself, examined the Linnæan cabinet, we all acquiesced in the same opinion; but we had all forgotten that the type of *Anomia crispa* formed part of the Tessinianian Collection, and we were ignorant at the time of the statement made by Hisinger, in vol. v of the 'Anteckningar' (1831). As, however, during so many years the terms *sulcata*, *crispa*, and *elevata* have been generally recognised, and made use of for the species published by Hisinger, Dalman, and others, it will be preferable, I think, not to disturb the present state of things, while pointing out what appears to be the probable type of Linné's *Anomia crispa*.

Bronn, at p. 1175 of his 'Index Palæontologicus,' considers *Anomia crispa*, Linné, *Delthyris sulcata*, His., and *Spirifer octoplicatus*, Sow. (pars; 'Min. Conch.,' tab. 562, fig. 4), as referable to a single species; but this last reference, or identification, is erroneous, for Sowerby's specimen, fig. 4, was obtained from the same rock and locality as figs. 2 and 3, namely, the Carboniferous Limestone of Derbyshire.

D'Orbigny, in his 'Prodrome,' retains also the *Delthyris crispa* of Hisinger (which he refers to Linné), as well as the *Delthyris sulcata* of the same author. In his enumeration of the Brachiopoda found by himself in the Island of Gothland, M. de Verneuil considers *Spirifer sulcatus*, *Sp. crispus*, and *Sp. elevatus*, as distinct species. I am, moreover, very uncertain whether M. Barrande is correct in referring fig. 2 of pl. xvii of his 'Silurische Brachiopoden aus Böhmen,' to *Delthyris sulcata*, His.; M. Barrande's shell being much larger, and differing much in detail from the specimens found in England and in Sweden.

As already stated, *Spirifera sulcata* has often one wing less extended than the other; and in some exceptional examples, one wing was much elongated and pointed, while the other was obtusely rounded; but this feature is common in those species of the genus which possess extended cardinal angles, as for instance, the Devonian *Spirifera Verneuilii*, &c. It must also be noted, that in the larger number of English and Swedish specimens of *Sp. sulcata*, the number of large or principal ribs is limited to three or five; the others, when they exist, being much smaller and even rudimentary. For this reason, I feel certain that the shells figured by Prof. Hall in the second volume of his 'Palæontology of New York' (p. 261, pl. 54, fig. 2, 1852), under the designation of *Spirifer sulcatus*, His., and *Delthyris decemplicata*, in the 'Report Geol. Third District New York' (p. 105, fig. 4, 1843), do not really belong to Hisinger's species, for they show a regular succession of from thirteen to seventeen ribs on each valve,—a condition never hitherto seen on any of the many Swedish and British examples of *Sp. sulcata* that have fallen under my observation. I do not, therefore, quote his figures. It is not improbable, however, that the true *Sp. sulcata* may be found in the Niagara Group of Lockport, or of other places in the United States.

Position and Locality. *Spirifera sulcata* occurs in the Wenlock Limestone at Dudley, Benthall Edge, Wenlock Edge, Lincoln Hill, and Hay Head, near Walsall; also in the Wenlock Shale, and the Wenlock Limestone of May Hill, Malvern, and Woolhope (Salter). It is not rare in rocks of a similar age in the Island of Gothland.¹

SPIRIFERA ELEVATA, *Dalman*. Pl. X, figs. 7—11.

DELTHYRIS ELEVATA, *Dalman*. Vet. Acad. Handlingar, f. 1827, p. 120, tab. iii, fig. 3, 1828.

— — *Hisinger*. Lethæa Suecica, p. 73, tab. xxi, figs. 3, a, b, 1837.

SPIRIFER OCTOPLICATUS, *Sow.* Silurian System, pl. xii, fig. 7, 1839 (not *Sp. octoplicatus*, *Sow.*, Min. Conch., tab. 562, 1827).²

— PTYCHODES, *Sow.* (not of *Dalman*). Sil. Syst., tab. iii, fig. 13, 1839.

? — SPURIUS (*Barrande*), *Davidson* and *De Verneuil*. Bull. Soc. Géol. France, 2nd ser., vol v, pp. 324 and 347, pl. iii, fig. 40, 1848.

SPIRIFERA PTYCHODES, *Phillips* and *Salter*. Mem. Geol. Survey, vol. ii, part 1, p. 293, 1848 (not of *Hisinger*).

SPIRIFER SUBSPURIUS, *D'Orbigny*. Prodrôme, vol. i, p. 42, 1849.

— ELEVATUS, *Idem*. Ibid.

— — *Morris*. Catal. Brit. Foss., p. 151, 1854.

— — *Salter*. Siluria, 2nd ed., pl. xxi, figs. 5, 6, 1859.

SPIRIFERA SUBSPURIA, *M'Coy*. Brit. Pal. Foss., p. 195, 1852.

Spec. Char. Transversely rhomboidal; hinge-line nearly or quite as long as the width of the shell; cardinal angles either angular or slightly rounded. Dorsal valve less convex than the opposite one, with from eight to twelve simple ribs, which are divided by a mesial fold, equalling in width the adjoining two ribs, moderately elevated, and grooved along the middle. Ventral valve much arched and gibbous; beak incurved; mesial sinus as wide as is the fold in the opposite valve, and margined by a strong rounded rib or ridge on each side; from four to six ribs on either side of sinus. Surface of both valves regularly crossed by numerous slightly projecting lines, as well as by delicate longitudinal and transverse striæ. Area triangular, moderately broad, fissure partly closed by a deltidium in two pieces. Specimens vary much in size; two measured—

Length 9, width 12, depth 8 lines.

„ 7, „ 9, „ 6 „

Obs. This shell is one of the most common in our Upper Silurian rocks. It varies

¹ I may here mention that, having received from my friend Lindström, of Wisby, a complete series of all the species of Silurian Brachiopoda hitherto discovered in Gothland, I have been able to carefully compare our British shells with those found in Sweden; and the student will be glad to know that Herr Lindström has sent a similar collection to the British Museum, which of course may be readily consulted there.

considerably in shape and number of ribs; and I am informed by Lindström, that in Gothland it is not uncommon to meet examples showing every passage from forms with large acuminate ventral valves and almost flat areas, to others wherein the area is so narrow that the beaks are almost contiguous. In Dalman's and Hisinger's figure, the area is unusually large and triangular. Sometimes our British specimens are as long as wide; and, when in fine preservation, the delicate longitudinal and concentric lines give to the shell under the lens a finely imbricated appearance. This is especially the case in casts. Prof. M'Coy states, that in casts the two dental plates in the ventral valve are thick and short; and that a faint trace of the mesial septum exists on the ridge of the dorsal valve.

This form more nearly resembles some specimens of Sowerby's *Spirifer octoplicatus*, than it does either *Spirifera sulcata* or *Sp. crispa*; and I am therefore not astonished that it should sometimes have been referred to the Carboniferous species. Indeed, some Devonian specimens seem undistinguishable from the Silurian shell. In 1848 M. de Verneuil and myself thought we could identify *Spirifer spurius*, Barrande, with the shell under description; but I am not quite certain as to the correctness of this view. *Sp. plicatus*,¹ Sharpe ('Quart. Journ. Geol. Soc.,' vol. iv), has also been considered a synonym of *Spirifera elevata*; and the specimens described and figured in the 'Palæont. New York,' vol. ii, p. 261, pl. liv, figs. 2 *a*, *b*, under the designation of *Spirifer sulcatus*, appear to me much more like *Spirifera elevata* than the shell to which they have been referred by Prof. James Hall. I am likewise quite at a loss to understand what can have induced Mr. Sowerby to identify the broken cast of *Spirifera* in 'Sil. Syst.,' tab. iii, fig. 13, with *Delthyris ptychodes*, Hisinger ('Leth. Succ.,' pl. xxi, fig. 8), and Dalman, 'Acad. Handl.,' tab. iii, fig. 5), to which it bears no resemblance. Sowerby's example above referred to belongs to *Spirifera elevata*; and his mistake has also been reproduced in Morris's 'Catalogue of British Fossils,' and by Phillips and Salter in the 'Mem. Geol. Survey,' vol. ii, p. 293, 1848. Salter corrected it in 'Siluria.'

Position and Locality. *Spirifera elevata* ranges from the Upper Llandovery to the Ludlow Rocks. It occurs in the Upper Llandovery beds at Damory Bridge, Tortworth; in the Wenlock Limestone of Dudley; Benthall Edge; Wenlock Edge; May Hill; Woolhope; Slate Mill, Hasguard, very large and fine (Salter); the Bell, Walsall; Hereford Beacon; north of Canwood; Dormington Wood and Lindel's Green, in the Woolhope district. It occurs not uncommonly in the Llandovery beds at May Hill and Huntley Hill, &c. Also in the Wenlock Shale of Marloes, and of Dingle, Co. Kerry; in the Lower Wenlock (or Denbigh) grit-beds of Modwl Eithin, of Plas Madoc, and east of Merchlyn and Llanrwst, North Wales; and at Marloes, Milford, Freshwater, Llandeilo, Llangadoc, and Llandovery, in Wenlock beds (Salter's MS. Catalogues).

In the Lower Ludlow beds, at Hole Farm, in the Abberley district; Dowlas, Coed-y-

¹ *Orthis plicata*, Vanuxem, Report, p. 112, fig. 1, *a*.

Pan, Cefn Ila, Ty Newydd, Cilorgyr, etc., in the Usk district; at Crew's Hill, Alfrick; at Cwm Craig ddu, &c.; also in Ludlow beds at Kendal in Westmoreland, and Dingle, Co. Kerry.

In the Aymestry Limestone of Sedgley, near Dudley, north-east of Pilliard's Barn, Bodenham, in the Woolhope district; Ankerdine Hill (Abberley district); Beech Hill, Llancayo, west of Darran, and Russell's Farm, in the Usk district.

In the Upper Ludlow beds at Dafaddfa Uchaf, in the Llandeilo district, South Wales, and Ludlow Lane; also at Frith, in the Malvern district.

Prof. McCoy says it is abundant in the siliceous Upper Ludlow rock of Lambrigg Fell, Benson Knott, and north end of Potter's Fell; all near Kendal, Westmoreland.

It is found also in the Downton Sandstone in the Woolhope and Ludlow districts.

On the Continent it occurs in rocks of the Wenlock age, in Gothland, as well as near Christiania in Norway. Prof. Schmidt has also found it in the Isle of Oesel.

SPIRIFERA CRISPA, *Hisinger*. Pl. X, figs. 13—15.

- TEREBRATULA CRISPA*, *Hisinger* (not of *Linnaeus*). Vet. Akad. Handlingar, tab. vii, fig. 4, 1826.
- DELTHYRIS CRISPA*, *Dalman*. Vet. Acad. Handl., p. 222, tab. iii, fig. 6, 1828.
- — *Hisinger*. Anteckningar, vol. iv, pp. 220 and 238, tab. vii, fig. 4, 1828.
- — *Id.* Ibid. vol. v, p. 119, 1831.
- — *Id.* Lethæa Suecica, p. 73, pl. xxi, fig. 5, a, b, 1837.
- SPIRIFER CRISPUS*, *Von Buch* (pars). Ueber Delthyris, &c., p. 40, 1837.
- — *Sow.* Sil. Syst., pl. 12, fig. 8, 1839.
- — *McCoy*. Synops. Irish Sil. Foss., p. 37, 1846.
- — *Davidson*. Bull. Soc. Géol. France, 2nd ser., vol. v, p. 325, pl. iii, fig. 42, 1848.
- ? — — *Hall*. Pal. New York, p. 262, pl. liv, fig. 3, 1852 (perhaps, *Sp. elevata*, *Dalman*).
- — *Schmidt*. Silur. Format. Ehstland, &c., p. 211, 1858.
- — *Salter*. Siluria, 2nd edit., pl. xxi, fig. 4, 1859.
- SPIRIFERA CRISPA*, *McCoy*. Brit. Pal. Foss., p. 193, 1852.
- — *Lindström*. Proc. Roy. Acad. Sc. Stockholm, p. 360, 1860.

Spec. Char. Shell small, transversely oval; valves moderately convex; hinge-line a little shorter than the width of the shell; cardinal angles rounded. Dorsal valve rather less deep than the ventral, with three, five, or seven ribs, of which the central one is the largest, although in elevation exceeding but little those that are next to it on either side. Ventral valve rather more convex than the opposite one, plications two or three on either side of sinus. The whole surface of both valves covered by numerous, sharp, regular, concentric, slightly projecting lines of growth: beak moderately incurved; area

triangular, of small dimensions; fissure partly margined by a deltidium. Two specimens measured—

Length 5, width 6, depth 4 lines.

„ 5, „ 5, „ 3 „

Obs. As already stated in our observations on *Sp. sulcata*, this shell, in 1826, 1827, and 1828, was considered by Hisinger and Dalman to be identical with the *Anomia crispa* of Linnæus, and it was only in 1831 that the first-named author found out his mistake. Since then, the same error, which originated in 1826, has been reproduced by all subsequent palæontologists, with the exception of Lindström. We will, however, retain the name of *crispa*, Hisinger (not of Linné), for the shell under description, as the term has been so generally made use of in this country as well as upon the Continent by every geologist and palæontologist who has had occasion to refer to it. My friend Lindström writes me, that he feels uncertain whether the species occurs in our British Silurian rocks; but, after having compared several Gothland specimens of *Sp. crispa* with others found in England, I can see no difference; and it may be here remarked, that Hisinger's figure is taken from a very young shell, and does not well represent the exact characters of fully developed specimens of his species.¹

Position and Locality. *Sp. crispa* occurs in May Hill Sandstone or Upper Llandovery at Ankerdine Hill: Woolhope Limestone, west of Worcester Beacon; Wenlock Limestone and Shale, Clungunford, Shropshire; Craig-y-Gareyd, Usk River; Dudley; Callow Farm, &c., Abberley; Rock Farm and Checkley Common, May Hill; Canwood and Dormington, Woolhope district; in Lower Ludlow at Eastnor Castle, Ledbury; Hole Farm, Abberley; Aymestry Limestone, at Ridge Hill Farm, Abberley (Phillips and Salter). It is a very common fossil in the Upper Silurian.

It occurs also in Wenlock Rocks near Llandeilo (M'Coy); Marloes Bay, Pembroke-shire; near Llangollen; Dunquin and Ferriter's Cove, Co. Kerry (M'Coy).

In Scotland it has been found by Mr. Henderson, in the Upper Silurian (Ludlow) Shales, at Deerhope Burn, in the Pentland Hills; and it occurs in the Wenlock Limestone at Kirkby Moor.

It occurs in Gothland; also in Oesel, according to Professor Schmidt; and in the Niagara rocks of New York, according to Prof. Hall. I do not feel certain, however, whether the American fossil really belongs to Hisinger's species.

¹ Hisinger describes his *Delthyris crispa* as follows: "Testâ transversali, convexo-gibbâ, longitudinaliter 5—6-plicatâ et subtiliter transversim striatâ; foramine magno deltoideo, natibus remotis." Dalman's description is exactly similar, and he has copied Hisinger's figure.

SPIRIFERA (CYRTIA) EXPORRECTA, *Wahlenberg*. Pl. IX, figs. 13—24.

- ANOMITES EXPORRECTUS, *Wahlenberg*. Nova Acta Regiæ Soc. Scient., vol. viii, p. 64, No. 3, 1821.
- CYRTIA TRAPEZOIDALIS, *Hisinger*. Bidrag. Sver. Geogn. Anteckn., vol. iv, p. 220, tab. iv, fig. 1, *a, b, c*, 1828.
- EXPORRECTA, *Dalman*. Kongl. Vet. Acad. Handl., p. 118, tab. iii, fig. 1, 1828.
- TRAPEZOIDALIS, *Id.* Ibid., p. 119, pl. iii, fig. 2, 1828.
- — *Hisinger*. Lethæa Suecica, p. 73, tab. xxi, fig. 1, *a, b*, 1837.
- EXPORRECTA, *Id.* Ibid., pl. xxi, fig. 2, *a, b, c*, 1837.
- SPIRIFER TRAPEZOIDALIS, *Von Buch*. Ueber Delthyris, &c., p. 41, 1837.
- — *Sow.* Sil. Syst., pl. v, fig. 14, 1839.
- — *Bronn*. Lethæa Geogn., tab. iii, fig. 3; Index Pal., p. 1183, 1848.
- — *Davidson*. Bull. Soc. Géol. France, 2nd ser., vol. v, p. 324, pl. iii, fig. 43, 1848.
- — *Barrande*. Naturwiss. Abhandl., vol. ii, pl. xvi, fig. 1, 1848.
- Plicatellus, var. EXPORRECTUS, *Salter*. Mem. Geol. Surv., vol. ii, pt. i, p. 382, 1848.
- — var. TRAPEZOIDALIS, *Id.* Ibid., p. 382, 1848.
- SPIRIFERA (CYRTIA) TRAPEZOIDALIS, *McCoy*. Brit. Pal. Foss., p. 196, 1852.
- SPIRIFER TRAPEZOIDALIS, *Salter*. Siluria, 2nd edit., pl. xxi, fig. 3, 1859.
- SPIRIFERA EXPORRECTA, *Lindström*. Ofv. Vet. Akad. Forhandl., p. 358, 1860.

Spec. Char. Trigonal; valves convex; hinge-line nearly or quite as wide as the width of the shell; cardinal angles rectangular, or obtusely rounded. Ventral valve pyramidal, much more convex than the dorsal, with an angular median sinus, extending from the extremity of the beak to the front. Beak straight or incurved, at times more or less inclined backwards: area variable in its dimensions, usually large, triangular, sometimes almost equiangular; fissure narrow, entirely arched over by a convex deltidium, which presents an elongated depression along its posterior portion, and terminated anteriorly by a small oval foramen, which became cicatrised with age. Dorsal valve semicircular; sides gently convex or rounded, forming a deep subquadrate lobe at the margin: the fold of moderate width and elevation, flattened along the middle. Surface of both valves covered with numerous, fine, longitudinal, raised, thread-like striæ, which increase in number as they proceed towards the margin by bifurcation as well as by the interpolation of additional striæ. In the interior of the ventral valve the hinge-teeth are supported by short shelly plates, which diverge and extend from the extremity of the beak, forming the fissure-walls, and occupying about one third of the length of the bottom of the valve: between these there exists a slightly raised longitudinal ridge (but not septum), which divides the muscular impressions. In the interior of the dorsal valve the

arms are supported by spiral coils, directed outwards. Shell impunctate. Two specimens measured—

Length 13, width 12, depth 9 lines.

„ 15, „ 14, „ 12 „

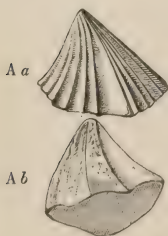
Obs. Palæontologists seem generally agreed to consider *Spirifera* (*Cyrtia*) *exporrecta*, and *Sp. (C.) trapezoidalis*, as simple variations in shape of a single species; and, since the designation *exporrecta* (Wahlenberg) appears to be the earliest name, it is here adopted in preference to that of *trapezoidalis*.¹ Although Wahlenberg refers to Walch² for a figure of his species, this must be a mistake, for the illustration in question does not (I believe) really refer to the species under description, or to the one to which the Swedish author had given the designation of *exporrectus*. Walch informs us, moreover, that his shell had been found at Mecklenburg, and therefore could not be the same as the Silurian specimen from Gothland; nor do Walch's figures agree with what Wahlenberg had in view when he described his *Anomites exporrectus*, for Walch's figure represents the exterior of the ventral valve of a *Spirifera* with strong angular ribs, while none such occur in the Silurian species, whose valves are, on the contrary, finely striated. In Walch's fig. A *♂*, also, the fissure, or deltidium, has not the character of the Swedish or British specimens of

¹ Wahlenberg gives the following description of his species in the 'Nova Acta Reg. Soc. Sc. Upsaliensis,' vol. viii, p. 64, 1821:

Anomites exporrectus, striatulus, nate alterius valvulæ exporrecta in conum dimidiatum dorso canaliculatum. Patella, Walch, in 'Naturforsch.,' 7, p. 216, tab. iv, fig. A *a*, et A *b* (Valvula longior). Reperitur rarius in Gothlandiâ, unde integrum exemplar nactus est Cel. J. Afzelius. Conus valvulæ longioris in hoc specimine superne paulo curvatus est, sed in aliis speciminibus imperfectis omnino rectus. De cetero valvulæ omnino jugatæ sunt ut in præcedente. Quin totâ structurâ aliquantum accedat ad famosam Hüpschii Pantoffelmuschel, non est infitandum.

² In the 'Naturforscher,' vol. vii, 1775, we find Walch's description and figures, which we copy here for the sake of reference:

IV. Von einem seltenen Patelliten aus dem Mecklenburgischen. Taf. iv, n. 1, *a*, *b*.



“Durch diese erhalten die Patelliten des Steinreichs die Hr. Diaconus Schröter im fünften Stück des Naturforschers so sorgfältig und so gründlich beschrieben, eine Bereicherung. Dieser Patellit gehört zu denen mit übergebogenem Wirbel, und unter solchen zu den sogenannten Dragonern. Auch diese Theilen sich in verschiedene Gattungen, unter welchen eine vom Hrn. Diac. Schröter, die auf der einen Seite gestreifte, auf der andern glatte Patelle von Wrietzen genannt, und von ihm in besagtem Theil. Taf. iii, num. 6, in einer Zeichnung geliefert wird.

“Von dieser Gattung ist diejenige Mecklenburgische, so ich hier mittheile eine Gattungsart. Sie unterscheidet sich von der Wrietzner durch die starke Furche oder vertiefte runde Falte auf der vordern gestreiften Fläche, welche Falten auf der hintern glatten Fläche, wie bey verschiedenen Pectunculiten erhaben ist. Dem ersten Auseln nach sollte man diesen Patelliten für einen Pectunculiten halten. Allein er ist es nicht. Die vordere gestreifte Fläche und die hintere glatte Fläche machen zusammen ein ganzes Schalenstück aus, die Grundfläche ist offen, und unbedeckt, so wie bey allen Patellen.”

Sp. exprorecta; but this is of little consequence, since both Dalman and Hisinger have correctly described and figured Wahlenberg's Silurian *Anomites exprorectus*, which we must retain, omitting the reference to Walch.

Spirifera (or *Cyrtia*) *exprorecta* varies considerably in shape, or rather in the dimensions and position of its area, as may be seen by a glance at the figures in our Plate; thus the triangular area, with an average breadth of eleven lines (at the hinge-line), and a length of from three to seven lines from the point of the beak to the hinge-line, would constitute Wahlenberg's, Hisinger's, and Dalman's *Anomites exprorectus*; while Hisinger, and after him Dalman, gave the name of *trapezoidalis* to those variations with a narrower area, as seen in fig. 17 of our Plate. This is not, however, the only difference observable in the area of this remarkable species; for in some examples it is completely flat, almost equilateral and equiangular (fig. 16), and it recedes at a right angle, or even at more than a right angle, from the plane of the dorsal valve, while in other specimens it is more or less concave and incurved at the beak. Another character of great importance in this species resides in the shape of its deltidium, which varies, it is true, slightly in different specimens, but is always narrow and lanceolate; and, whatever may be its length, it does not appear to much exceed one line and a half in width at its base. It also entirely covers over the fissure; and in the Swedish and British examples it presents an elongated depression, which, commencing at the extremity of the angular beak, extends to a lesser or greater distance along its surface, and even sometimes to within a small distance of its basal extremity.¹ At the inward extremity of this flat or slightly concave depression may be seen in many specimens, but not in all, a small oval aperture, which however is often cicatrised, leaving only a slight mark to indicate its former presence. The animal was no doubt attached during a part of its existence to marine objects by means of a pedicle, but with this moorage it afterwards dispensed. These arrangements have been carefully represented in the enlarged figures 19, 20, and 21 of our Plate.² This character of the

¹ Barrande's figures of the Bohemian specimens of this species show no indication of the depression above described, nor of the foramen; the deltidium being equally convex throughout. Hence, the depression in question may, perhaps, not always have been present.

² For the reception of these shells, Dalman, in 1827, proposed the genus *Cyrtia*, with the following diagnosis:

"Testa inequivalvis æquilatera, valvæ majoris dorso in semiconum vel pyramidem dimidiatum elevato, latere cardinali perpendiculariter plano,—foramine nullo. Cardo rectilineus." But, as I have already stated, at p. 83 of my "General Introduction," Dalman's diagnosis is unsatisfactory, and equally applicable to several species of *Spirifera*; and the only character of any value that I can perceive, by which it might be distinguished from *Spirifera*, consists in its having the fissure entirely arched over by a deltidium which was at some period of the animal's existence perforated by a circular foramen. Even this last character, however, is not present in all the specimens referable to this so-termed genus. In one remarkable form, *Cyrtia Murchisoniana*, the circular foramen, which sometimes presents a small, marginal tubular prolongation, is situated at, or close to the extremity of the beak, or of a long narrow deltidium, as may be seen in some Chinese specimens of the species which I described and figured in the "Quarterly Journal of the Geol. Soc." (vol. ix, p. 353, pl. xv, figs. 6—9, 1853). If, therefore, the term *Cyrtia* is to

deltidium is likewise so different from that observable in *Spirifera plicatella*, that it is quite sufficient to prevent the possibility of the last-named shell being considered as a variety, due to a difference in shape, of *Spirifera (Cyrtia) exporrecta*: and the same would apply to *Sp. (C.) trapezoidalis*, which is, as we have already shown, a synonym of *Sp. exporrecta*. It was long before I could expose portions of the spiral coils, and only after having broken open a large number of specimens. These coils are disposed as in *Spirifera*; and the muscular arrangements are also the same. In the internal casts, as observed by Prof. M'Coy, the slits left by the dental plates are very strongly marked in the ventral valve, and our British examples agree entirely with those found in Gothland; but the deltidium is not correctly represented in either Hisinger's or Dalman's figures.

Position and Locality. In England *Spirifera exporrecta* ranges from the Lower Llandovery to Ludlow Rocks (Salter), and is common in the Wenlock Limestone and Ludlow Shale through Shropshire; also of Dudley and Abberley; the Wenlock Shale of Rushall Canal, near Walsall; of Craig-y-Garced, Usk; of Nelson's Tower Wood, Llandeilo. In fact, all through Carmarthenshire. It occurs too, but more rarely, in the Upper Llandovery or May Hill Sandstone of Tortworth, at Damory Bridge; in the Wenlock or Woolhope (Denbigh) grit of Plas Madoc, Llanrwst, and other places in Denbighshire; in the Woolhope Limestone, Storridge, and under Worcester Beacon, Malvern; and in the Lower Ludlow of Dog Hill, Ledbury.

In Scotland it has been discovered by Messrs. Haswell and Brown, chiefly in the condition of internal casts, in the Upper Silurian (Wenlock) shales of the Deerhope Burn, near the North Esk Reservoir, Pentland Hills.¹

be retained, it cannot, I think, be considered in any other light than that of a subgenus or section of the great genus *Spirifera*.

¹ A specimen from this locality is figured in pl. iii of Mr. Haswell's little book on the 'Silurian Formation in the Pentland Hills' (1865); but at that period, owing to the imperfect condition of the cast, neither its species nor genus could be accurately determined. Since then, the discovery of more perfect specimens has enabled me to refer without doubt these casts to *Spirifera (Cyrtia) exporrecta* of Wahlenberg.

Since so many species of Brachiopoda have been discovered in the Upper Silurian rocks of the Pentland Hills, it may be interesting to append a short note upon the subject, kindly forwarded to me by Mr. A. Geikie, of the Geological Survey of Scotland. "Under the massive unconformable conglomerate of the Pentland Hills, lies a series of highly inclined and even vertical strata, which for many years were classed with the 'Greywacke' of the 'transition' rocks of the south of Scotland. Two *Orthoceratites* had been found in these strata previous to the year 1839, by the late Mr. Charles Maclaren, but the specimens went amissing, and the species was not determined at the time of the publication of his 'Geology of Fife and the Lothians.' One of the specimens eventually found its way into the Collection of Hugh Miller, who showed it to me. It was lent by him some time before his death to Sir R. Murchison, with the view of being named and described in the next edition of 'Siluria.' Before that edition appeared, however, in 1858, the Geological Survey had begun to map the area of the Lothians, and I had succeeded in detecting in the so-called 'Greywacke' of the Pentland Hills several other fossils. The *Orthoceras* was named *A. Maclareni*; and it most resembled a Wenlock species. The Silurian rocks of the

It occurs in the Island of Gothland; and was found by M. Barrande in the Silurian rocks of the neighbourhood of Prague, in Bohemia, where the shell attained larger dimensions than it appears to have ever had in England or Sweden.

Palæontologists have, in various works, described as Spirifers several other shells that I find do not belong to the genus, and which will be found under other names in

Pentland Hills are regarded by Sir Roderick as Upper Silurian, and some of them are probably of Wenlock age. Further examination of the tracts on the North Esk and Lyne Water showed that at places these Silurian rocks are richly fossiliferous. I made a considerable collection, which was afterwards largely increased by the labours of Mr. Salter and Mr. R. Gibbs. The result of these researches went to show that, at least, the upper portion of the Silurian series of the Pentland Hills is of the age of the Ludlow rock; while certain red sandstones and conglomerates overlying the olive-coloured fossiliferous beds were held to mark the base of the Old Red Sandstone.

"The following is the section, in descending order, as far as the disturbed character of the strata will allow it to be made out. Red conglomerates, sandstones, and shales = Base of the Lower Old Red Sandstone (?).

"3. Olive and brown sandy shales, sandstones, and mudstones, some of the beds full of Ludlow fossils.

"2. Hard sandstone and beds of quartzose grit, containing among other obscure shells, *Orthonota amygdalina*, *Mytilus*, *Avicula*, a shell like *Platychisma simulans*, *Orthoceras*, and numerous fragments like Fish plates or scales.

"1. A thick series of green, grey, and reddish shales, with bands of hard grit and sandstone, containing in some places abundant remains of *Dictyocaris*.

"The basis of this series is concealed under the conglomerates of the Middle (?) Old Red Sandstone series; but the whole visible thickness of the Upper Silurian rocks was estimated by me to range between 3000 and 4000 feet. In this mass of strata, while the upper portion is undoubtedly of Ludlow age, there is room also for the representation of the Wenlock Rocks."

Subsequently to Mr. Geikie's researches, several members of the Geological Society of Edinburgh, among whom we may more particularly name Messrs. G. C. Haswell, D. J. Brown, and J. Henderson, have devoted much time to the study of these beds and to collecting their fossils; and I had the pleasure of visiting the locality during the spring of 1866. Mr. Haswell has also, in an interesting little brochure, 'On the Silurian Formation in the Pentland Hills' (1865), given us a description of the locality, and of many of its fossils. He is of opinion that it is in the "Mudstone II" of his map, in Deer-Hope Burn, and belonging to the Wenlock period, that the greatest number of Brachiopoda occur; while, in the upper beds (at "I" of his map, and on the same stream), referable to the Ludlow, the only Brachiopods hitherto found are *Rhynchonella Pentlandica*, *Spirifera crispa*, and *Lingula lata*.

The following is a list of the species of Brachiopoda I have been able to determine from these beds. They have been collected by the gentlemen above named; and in an interesting paper read by Messrs. Brown and Henderson to the Geological Society of Edinburgh, will be found some new and important matter in connection with the distribution of these fossils.

Lingula lata, Sow.; *Discina rugata* (?), Sow.; *Crania implicata*, Sow.; *Spirifera crispa*, His.; *Sp. (Cyrtia) exporrecta*, Wahl.; *Meristella tumida*, Dal.; M. (?) *Maclareni*, Haswell; *Athyris compressa*, Sow.; *Nucleospira pisum*, Sow.; *Atrypa reticularis*, Lin.; *Rhynchonella Pentlandica*, Haswell; *Rh. Wilsoni*, Sow.; *Rh. nucula*, Sow.; *Rh. crispata* (?), Sow.; *Orthis elegantula*, Dal.; *O. biloba*, Lin.; *O. Lewisii*, Dav.; *O. calligramma*, Sow. (?); *O. ? minuta*, Haswell; *Strophomena applanata*, Salter; *St. pecten*, Linn.; *St. antiquata*, Sow.; *St. rhomboidalis*, Wahl.; *St. Walmstedti*, Lindström; *Leptæna transversalis*, Dal.; and *Chonetes striatella*, Dal.

this Monograph. Those described in the preceding pages are the only British Silurian species of the genus with which I am at present acquainted.

In a paper on the Pebble-bed of Budleigh-Salterton, published in the 'Quart. Journ. Geol. Soc., London,' vol. xx, p. 295, pl. xvii, figs. 10 and 13, Mr. Salter describes two species of *Spirifera*, *Sp. antiquissima*, Salter, and *Sp. David'si*, Rouault (?), as of perhaps Lower Silurian age; but that distinguished and experienced palæontologist does not omit to add, "These are the oldest known species of the genus; if indeed it be not the case that there are, as above suggested, pebbles from some Devonian rock, mixed with others." Since the above lines were published, I have received from Messrs. Vicary and Valpy the loan of a considerable number of specimens of the above-named species, and I am of opinion that they are of Devonian age, and referable to a single species, that species being *Spirifera Verneuilii*, Murchison, a well-known and far-spread Devonian shell. I may likewise add, that, after a careful study of several hundred specimens of Brachiopoda from the Budleigh-Salterton Pebble-bed, collected by Messrs. Valpy, Vicary, and Winwood, I was able to make out some thirty distinct species of Brachiopoda, of which more than half are, in my opinion, of Devonian age, while some few only appear to be Silurian.

Genus—NUCLEOSPIRA, Hall.

HALL, Palæontology of New York, vol. iii, p. 219 (printed in 1857, published in 1859); and Twelfth Report on the State Cabinet, New York, p. 24, 1859.

Types—NUCLEOSPIRA VENTRICOSA, N. CONCINNA, and N. PISUM.

Never having had the opportunity of studying the interior character of this genus, otherwise than through the medium of Prof. Hall's description and figures, I cannot do better than reproduce the author's diagnosis.

"Shell spheroidal or transversely elliptical, more or less gibbous or ventricose, furnished with internal spires as in *Spirifer*: hinge-line shorter than the width of the shell; cardinal extremities rounded: valves subequal, articulating by teeth and sockets. Ventral valve having the beak extended beyond the opposite valve; and beneath it a triangular depression or area, which sometimes terminates in a shallow spoon-shaped pit, on each side of which, at the base, is a strong tooth. A narrow ridge or septum extends along the centre of the inner side of the valve, from beak to base. Dorsal valve furnished with a strong spatulate cardinal process, which, rising vertically from the cardinal margin, is closely grasped at its base by the cardinal teeth of the other valve; and thence bending abruptly upwards, and expanding, is projected into the cavity of the opposite beak, lying close upon the underside of the false area. This process is grooved or depressed in the centre of the upper side, so as to leave between it and the arch of the ventral beak a

narrow space for the passage of a pedicle, for the protrusion of which a minute foramen is sometimes observed in the beak. From the sides of this process, above the junction of the teeth of the opposite valve, and at the point where it bends upwards, originate the crural processes which support the spires. A deep cavity beneath the cardinal process extends to the dorsal beak, from which originates a thin elevated septum, running to the base of the shell. Muscular imprints confined to a narrow oval space. Surface apparently smooth; under a lens, punctate; shell-structure dotted, and, when perfect, covered with minute hair-like spines.

“*Observations.* In Murchison’s ‘Silurian System,’ Mr. Sowerby has described, under the name *Spirifer ? pisum*, a species differing essentially in general external characters from the typical forms of that genus. This species has been adopted as a true *Spirifer* in Morris’s ‘Catalogue of British Fossils,’ and in the ‘Nomenclator Palæontologicus’ of Bronn, as well as elsewhere. Subsequently I discovered in the Niagara Shales a form so similar to the British species that I regarded it as identical; but from the condition and character of the specimens, I considered them as more nearly allied to *Orthis* than to *Spirifer*, and, accordingly, in the Second Volume of the ‘Palæontology of New York,’ I designated the Niagara fossil ‘*Orthis pisum*.’

“Since that period my collections from the Helderberg have revealed a species similar to the one from the Niagara group; but among the numerous individuals from the latter rocks, I found several which were clearly furnished with internal spires like the true *Spirifer*, thus separating it from *Orthis* by unequivocal characters. Finding no genus for the reception of these forms, I described the latter as *Spirifer ventricosus*; and it has been so published in my Descriptions of New Palæozoic Fossils in the ‘Report of the Regents of the University upon the State Collections of Natural History.’

“Further examination has satisfied me of the impropriety of placing this fossil under either of the genera named, for several reasons. The central depression, line, or narrow sinus, which might be regarded as the mesial sinus of *Spirifer*, is almost equally a character of both valves. The apparent area is not a true area; and the apparent foramen, being merely a depression in the false area, does not correspond to the foramen either of *Spirifer* or of *Orthis*, not opening into the cavity of the shell. The hinge-line is not extended in the manner of these shells, particularly of the former; while the presence of a spire sufficiently distinguishes it from the latter.

“The lower Helderberg group furnishes one, and perhaps two other species; and I find that the fossil described by me as *Atrypa concinna* in the ‘Report of the Fourth Geological District’ (1843) is another species belonging to the same group of fossils, in which both the external characters and internal structure differ so essentially from any of the described genera of Brachiopoda as to constitute a distinct genus, and which, from the general nucleolar character of the known species, I propose to designate NUCLEOSPIRA.”

NUCLEOSPIRA PISUM, *Sow.* (sp.). Pl. X, figs. 16—20.

SPIRIFER ? PISUM, <i>Sow.</i>	Silurian System, p. 630, pl. xiii, fig. 9, 1839; and 'Siluria,' 2nd edit., pl. xxi, fig. 7, 1859.
SPIRIFERA —	<i>Phillips and Salter.</i> Mem. Geol. Surv., vol. ii, p. 293, 1848.
SPIRIFER —	<i>Dav.</i> Bull. Soc. Géol. France, 2nd ser., vol. v, p. 325, 1848.
—	<i>Bronn.</i> Index Pal., p. 1180, 1848.
ATRYPA —	<i>D'Orb.</i> Prodrome, vol. i, p. 37, 1849.
HEMITHYRIS? —	<i>M'Coy.</i> Brit. Pal. Foss., p. 205, 1852.
ORTHIS —	<i>Hall.</i> Pal. New York, vol. ii, p. 250, pl. lii, fig. 1, 1852.
NUCLEOSPIRA —	<i>Id.</i> Ib., vol. iii, p. 218, 1859.
SPIRIGERA ? —	<i>Lindström.</i> Öfv. K. Vet. Akad. Förhandl., p. 361, 1860.

Spec. Char. Shell small, suborbicular, very convex; valves almost equally convex, and gibbous near the beaks; beaks very small, incurved, that of the ventral valve being a little more elevated or projecting than that of the opposite valve; hinge-line straight, much shorter than the width of the shell; cardinal angles rounded; sides and front circular, or slightly narrowed and indented in front. Ventral valve a little deeper than the dorsal valve, with a slight depression down its centre. Dorsal valve most convex close to the umbone, with a faint line along its centre; but after reaching to about the centre of the valve, this line is gradually converted into a slight depression or sulcus. False area small, triangular, with a depression in the middle. Surface of both valves closely covered with long, slender, hair-like spines; but when these are destroyed by fossilization, the shell appears smooth and minutely punctate. Interiorly, each of the spiral coils is composed of six or seven convolutions, and are fixed to the hinge-plate of the dorsal valve. Two specimens measured—

Length 4, width 5, depth 3 lines.

„ 5½, „ 5, „ 3 „

Obs. As will be seen from the list of references, this small shell has been placed in no less than six different genera, namely, *Spirifera*, *Atrypa*, *Hemithyris*, *Orthis*, *Spirigera*, and, lastly, in *Nucleospira*, where I trust it may find a permanent home. Dr. Lindström informs me that Prof. Angelin named this species *Terebratula pachygaster* in his 'Musæum Palæontologicum Suecicum,' 1838. At p. 205 of his 'Brit. Pal. Fossils,' while treating of this shell, Prof. M'Coy states—"I have ascertained, by carefully breaking a specimen, that there are no internal spiral appendages, and therefore the species does not belong to *Spirifer*; and I have observed a large triangular opening beneath the beak, so that it does not belong to *Atrypa*, where M. d'Orbigny has placed it." That Prof. M'Coy should not have discovered the spirals after breaking a specimen is not surprising, and he might have broken twenty more without discovering a trace of their existence, for they appear to have been very often destroyed in the process of fossilization. I have

myself broken and sliced many specimens of different species which possess spiral appendages before obtaining them. It is therefore not always safe to assert that a species may not have possessed certain appendages because they are not exposed on breaking a specimen. Now, in *Nucleospira pisum* they may often be seen without fracturing the shell, through its transparent walls, as in the specimen fig. 18 of our Plate. The internal details of this species have been already given in full by Prof. Hall, in the generic description, and consequently need not be again repeated; but we must mention the long hair-like spines which so closely cover the perfect shell; and my attention was first turned to this circumstance by Dr. Holl, who sent me a specimen so invested, which he had discovered in the Wenlock Limestone of Colwall Copse; and there are others preserved in the Natural History Museum at Worcester.

Position and Locality. *Nucleospira pisum* occurs in the Wenlock Limestone and Shale of Hay Head, near Walsall; Wren's Nest, Dudley; and Benthall Edge, in the Wenlock district; Colwall Copse, Malvern; Dormington and Lindels, in the Woolhope district. Under Worcester Beacon, in Woolhope Limestone. In Scotland internal casts have been recently discovered in the Wenlock shale of the Pentland Hills, by Messrs. D. J. Brown and J. Henderson, of Edinburgh. These I will figure in the Supplement. This species has also been found in Gothland. Prof. Hall obtained it from Walcott, New York State, in shales of the Niagara Group.

Genus or Sub-genus MERISTELLA, Hall, 1860.

Hall. Thirteenth Report on the State Cabinet of New York, p. 73, 1860.—Fifteenth Report, &c., p. 179, 1862.—Sixteenth Report, &c., p. 50, 1863.

I need not here repeat the reasons which induced Prof. Hall to propose the generic or subgeneric designation of *Meristella* for shells typified by *Atrypa tumida* of Dalman; these details are given in a foot-note in pp. 13, 14, and 15 of my 'Monograph of Devonian Brachiopoda,' 1864.

At p. 50 of the 'Sixteenth Report' Prof. Hall adds the following observations to those he had published in 1860:—"The genus *MERISTELLA* includes *Terebratuloid* or *Athyroid* forms which are ovoid, more or less elongate, sometimes elliptical in outline, and not unfrequently transverse or sub-circular; valves unequally convex, with or without a median fold and sinus; and this feature, when present, usually confined to the lower half of the shell. Ventral beak more or less closely incurved (when closely incurved, apparently imperforate), terminated by an aperture, the lower side of which may be formed

by the umbo of the dorsal valve, or by a deltidium; area none; valves articulated by teeth and sockets. Surface smooth, or marked by fine concentric lines of growth (not lamellose), and indistinct or obsolescent radiating striæ, which are usually more conspicuous in the cast or exfoliated surfaces than on the exterior. Shell fibrous. The ventral valve is much thickened on each side towards the beak, and the rostral cavity margined by flattened dental lamellæ, which extend downwards to the commencement of the muscular impressions, and terminate at the edge of the shell in blunt, tooth-like processes. The muscular impression forms a somewhat broadly triangular depression in the valve, just below the rostral cavity. In the cast of this valve we have the reverse of these features. In the dorsal valve there is a strong hinge-plate or process, the prominent part of which is broadly triangular, somewhat depressed or spoon-shaped in the centre, and supported below by a median septum, which reaches from one third to one half the length of the valve, and on each side marked by deep dental fossets, while the anterior angles are produced into the crura which support the internal spires. Spires arranged as in *Athyris* and *Merista*, being a double cone with the apices directed outwards. From the lower lateral margins of the cardinal process or hinge-plate there is a callosity extending beneath the anterior to the dental fossets, and joining with the thickened margin of the valve, as in the other allied genera.

"In the cast of the dorsal valve we have the mark of the median septum, with an elongated lanceolate muscular impression, reaching nearly to the middle of the valve. The imprint of the triangular process, and the cavities made by the crura, are often preserved. . . . The difference between *Athyris* (= *Spirigera*) and *Meristella* are everywhere clear and unmistakable, in the external lamellose surface of the one and the almost smooth character of the other. The muscular impressions of the ventral valve of *Athyris* are at once distinguishable from those of *Meristella*. In the dorsal valve, the muscular impressions differ from *Meristella*, the hinge-plate is of somewhat different character, and the median septum is scarcely developed."¹

I must, however, hasten to observe that, from want of sufficient material, it has not been possible for me, in some cases, to determine with absolute certainty whether some of the species should be placed in the genus *Atrypa* or *Meristella*.

¹ At pages 282—303 of the fourth volume of his 'Palæontology of New York' (1857), Prof. Hall describes, at great length, the characters which distinguish *Meristella* from *Athyris*; and he illustrates a series of very remarkable preparations made by Mr. R. P. Whitfield, showing the very complicated manner in which the two spiral coils are attached to each other in the middle, as well as to the hinge-plate, in various species of the above-named genera. This, though different in detail, bears a certain resemblance to what I described and figured in *Athyris pectinifera*, at p. 21 of my 'Monograph of British Permian Brachiopoda.'

MERISTELLA TUMIDA, *Dalman* (sp.). Pl. XI, figs. 1—13.

- TEREBRATULA OBTUSA, *Sow.* Trans. Linn. Soc., vol. xii, p. 516, pl. xxvii, figs. 3, 4, 1815.
- ATRYPA TUMIDA, *Dal.* Vet. Akad. Handl., p. 134, pl. v, fig. 3, 1828.
- TEREBRATULA TUMIDA, *Von Buch.* Ueber Terebrateln, &c., p. 103, 1834.
- ATRYPA TUMIDA, *Hisinger.* Lethæa Suecica, p. 77, pl. xxii, fig. 5, 1837.
- TENUISTRATA, *Sow.* Sil. Syst., pl. xii, fig. 3, 1839.
- TEREBRATULA TUMIDA, *Barrande.* Sil. Brach. aus Böhmen; Naturw. Abhandl., vol. i, pl. xv, fig. 11, 1847.
- — *Dav. et de Vern.* Bull. Soc. Géol. France, 2nd ser., vol. v, pp. 226 and 246, pl. iii, fig. 26, 1848.
- — *Bronn.* Index Pal., p. 1254, 1848.
- ATRYPA TUMIDA, *Phillips and Salter.* Mem. Geol. Surv., vol. ii, p. 279, 1848.
- MERISTA — *Schmidt.* Silur. Format. Ehstland, &c.; Archiv Nat. Liv. Ehst- und Kurlands, vol. ii, p. 209, 1858.
- SPIRIGERA — *D'Orb.* Prodrôme, vol. i, p. 43, 1849.
- ATHYRIS — *M'Coy.* Brit. Pal. Foss., p. 196, 1852.
- — *Morris.* Cat. Brit. Foss., p. 131, 1854.
- — *Salter.* Siluria, 2nd edit., pl. xxii, fig. 20, 1859.
- MERISTELLA TUMIDA, *J. Hall.* Thirteenth Annual Report of the Regents on the State Cabinet of New York, p. 73, 1860.
- MERISTA — *Lindström.* Öfv. K. Vet. Akad. Forhandl., p. 161, 1860.

Spec. Char. Shell variable in form, subcircular or rotundo-quadrate, usually a little wider than long; sometimes the width not exceeding the length. Valves almost equally deep and tumid. Dorsal valve uniformly convex to about the middle; the fold, which is confined to the anterior half, gradually rising from the lateral portions of the shell into a squarish elevation, divided along the middle by an angular depression or groove, which is continued to the umbone. The fold is also usually curved upwards, so that when viewed in profile the valve is convex from the umbone to about half its length, forming afterwards a concave curve to the extremity of the fold. Ventral valve convex, with a wide square or obtuse sinus, commencing at about the middle of the valve, and extending to the front. It is also divided by a narrow groove, which, originating at the extremity of the beak, extends to the front. The lateral margins are rounded; front margin straight when the shell is young, but gradually rising, so as to form a rotundato-quadrate lobe towards the dorsal valve: beak small, and so much incurved as to almost touch the umbone of the opposite valve; no area or foramen visible. Surface of valves smooth, or marked only by fine concentric lines of growth, which are here and there stronger. The interior of the ventral valve is thickened at the beak, and especially for some short distance between the two strong dental plates, which extend along the bottom of the valve by a concavo-convex curve to

about the middle of the valve, leaving between them a pear-shaped depression filled by the scars of the oclucosor and adjustor muscles. The interior of the dorsal valve has, under the incurved beak, a small hinge-plate, divided in the middle; each half broadly triangular and depressed along the centre; these hinge-plates are supported below by a median septum, which extends to a little more than one third of the length of the valve. On the outer side of the hinge-plate are excavated the dental sockets, and to the hinge-plate is attached a complicated system of lamellæ, which form the spiral coils, with their extremities directed outwards or towards the lateral margins of the shell; each spiral being composed of about fifteen convolutions. The adductor or oclucosor muscular impressions are oval scars close to and on either side of the lower portion of the septum. Ovarian pits are also in some specimens observable on the visceral portion of the interior. Two specimens measured—

Length 23, width 23, depth 17 lines.

„ 16, „ 20, „ 12 „

Obs. I have devoted an entire Plate to the variations in shape assumed by this remarkable species. Fig. 9 is viewed from the beaks, in order to show the two diverging lines, which are in some specimens visible through the transparent shell, and which, commencing at the extremity of the beak in the ventral valve, extend to about one third of its length. These, and the single central line in the dorsal valve, indicate the position of the hinge-plates and septum in the interior. The external surface in all the many specimens I have examined was smooth; but when the specimen is slightly decorticated, the fine radiating striæ described by Mr. J. de C. Sowerby are observable. The species appears to have been described for the first time about 1815, by J. Sowerby, under the designation of *Terebratula obtusa*; and he also at the same time gave a figure of the exterior, and another in which portions of the spiral coils were exposed, so that in reality, were the rules of priority to be strictly adhered to, the shell under description ought to retain the designation of *Meristella obtusa*, Sow., sp.¹

In 1827 the same shell received from Dalman the designation of *Atrypa tumida*; and,

¹ In vol. xii, p. 515, of the 'Linnean Transactions,' Sowerby describes his shell in the following words:—“Since I presented a sketch of an *Anomia* or *Terebratula* with internal cartilage (it was *Spirifera striata*), I have received a species of *Terebratula* of a very different construction, with a spiral cartilage; and I conceive that a figure of this species would be a convenient addition to my former communication, as showing that the spiral cartilage is less confined to shells of a certain external form than might have been expected. Such as I had seen before had straight elongated hinges, and the deeper shell had a triangular foramen, or distant curved beaks indicating it; the present sketch, figs. 3, 4, represents a shell curved laterally from the hinge, which must be very short; the beaks are very small, and without any space for a triangular foramen externally; although within there appears a nearly triangular appendage to the cartilage, which, if not possessed of the outer shell, might indicate a triangular foramen. I presume to lay this sketch before the Society, hoping the subject will meet with attention and investigation when opportunity offers. The construction of the shells in my former communication would, without the present specimen, have given an idea of the straight hinge being peculiar to those *Terebratula* with a spiral cartilage, as agreeing with

as this specific name has been generally adopted, it would not, I think, be desirable to alter it now, especially as no one has made use of Sowerby's name. It is, however, strange that Mr. J. de C. Sowerby, who was fully cognisant of his father's prior claims, since he quotes them in his description, should, in 1839, have described the same shell under the appellation of *Atrypa tenuistriata*, a name which has not, however, been subsequently adopted. Mr. Salter first referred the English shell to Dalman's *Atrypa tumida*; and the shell has since been shifted from genus to genus, as will be seen by a glance at our list of Synonyms, until it has finally been taken as the type of Prof. Hall's genus *Meristella*.

Position and Locality. *Meristella tumida* is a common shell in the Wenlock limestone of Dudley, Woolhope, Benthall Edge, the Rushall Canal near Walsall, May Hill, &c. Prof. Phillips and Mr. Salter mention Storridge, Ledbury, Hereford Beacon, and Eastnor Park in the Malvern District, and the Wenlock limestone and Lower Ludlow of Hill End, at Abberley and Callow Farm in the Abberley district. North of Canwood, Dormington Wood, East of Canwood and Lindels, in the Woolhope district. West of Rock Farm, Rock Farm, North of Taynton, in the May Hill district. In the Aymestry limestone of Llanbadoc and Russell's Farm, in the Wenlock limestone and shale of Cilfegan, Ty-newydd, Trostrey, Bryn Craig, Craig-y-gareyd in the Usk district, and at Ty-newydd, Keeper's Lodge, &c., in the Llandeilo district. In Scotland it has been found by Mr. J. Henderson, in the Wenlock shales of the Pentland Hills. It occurs in Gothland; also in the neighbourhood of Christiania in Norway. Prof. Schmidt mentions having found it in Russia; and M. Barrande obtained it near Prague in Bohemia.

MERISTELLA ANGUSTIFRONS, *M'Coy* (sp.). Pl. X, figs. 21—27.

HEMITHYRIS ANGUSTIFRONS, <i>M'Coy</i> .	Ann. Mag. Nat. Hist., 2nd ser., vol. viii, p. 391, 1851; Brit. Pal. Foss., p. 199, pl. 1 H, figs. 6 to 8, 1852.
TEREBRATULA —	Salter. Quart. Journ. Geol. Soc., vol. vii, pl. ix, fig. 10, 1851.
RHYNCHONELLA —	Morris. Cat. Brit. Foss., p. 146, 1854.
—	Salter. 'Siluria,' 2nd edition, p. 230, Foss. 48, fig. 2, 1859.

Parkinson and Martyn, and might therefore have been misleading. The spiral remains in the present species seem rare, as most of the shells are filled with a hard marly earth. It was found with some other species in Sladacre's Quarry, on the right hand side of the road leading from Wych to Colwell Green, a part of the Malvern Hills." I have experienced some difficulty in ascertaining exactly the date at which Sowerby's description of *T. obtusa* was really published. The date at the commencement of vol. xi of the Linnean Society's Transactions is 1818; but the part containing Sowerby's description of *T. obtusa* has the date wanting. The paper, however, appears to have been read partly on the 6th of December, 1814, and partly on February 17th, 1815.

Spec. Char. Ovate, longer than wide; valves almost equally and regularly convex; no regular fold or sinus, but a slight elevation is perceptible near the front in the dorsal valve; sides rounded, and narrowed towards the front, which is also either straight or gently rounded. Beak more or less incurved, with a small triangular opening visible under its angular extremity; but this is often concealed by the incurvation of the beak. Surface smooth, marked only with a few concentric lines of growth. Shell-structure impunctate. Two specimens measured—

Length 9, width 6, depth $4\frac{1}{2}$ lines.

„ 9, „ 7, „ 5 „

Obs. Prof. M'Coy was the first to describe this species; but he was in error when placing it in d'Orbigny's genus *Hemithyris*, which is itself no more than a synonym of *Rhynchonella*; for, as may be seen in a specimen discovered by Mr. J. Thomson (fig. 25), the shell was provided with spiral processes, and is a *Meristella*. Nor could it, for the same reason, be classed with *Terebratula*. In certain localities it abounds in the condition of internal casts, which, in Prof. M'Coy's words, "show in the entering [dorsal] valve, two sub-parallel, approximate, longitudinal sulci, marking the inner [outer] edges of the muscular impressions, and with a fainter sulcus between them, left by the slight mesial septum; two pits near the beak, left by the apophyses, strong. Receiving [ventral] valve with two strong dental lamellæ, one each side of the beak, and a slight indication of a mesial septum: a few straight, once- or twice-branched impressions of the pallial vessels on each side." The shell is usually of an elongated oval form; but some examples are almost circular, and even occasionally, though rarely, a little wider than long. I cannot consider Prof. Schmidt correct in placing *M. angustifrons*, M'Coy, among the synonyms of *Atrypa cassidea*, Dalman (Silurische Formation von Ebstland, Nord-Livland und Oesel; Archiv, &c., 1858, p. 209).

Position and Locality. At p. 230 of 'Siluria' (1859) this fossil is quoted by Salter as one of the characteristic fossils of the Lower Llandovery rocks. In Scotland it occurs by millions in a greenish and rusty-coloured sandstone at Mullock Hill, Dalquharran, Craighead; as well as in other localities of the Girvan Valley, Ayrshire. Mr. Salter traced this species in the Llandovery formation in South Wales, along the borders of South Wales, at Rhayader, Cilgwyn, and Pen-y-lan, near Llandovery; also near Builth.

MERISTELLA DIDYMA, *Dalman* (sp.). Pl. XII, figs. 1—10.

TREBRATULA ? DIDYMA, *Dalman*. K. Vet. Akad. Handl., p. 146, pl. vi, fig. 7, 1828.

ATRYPA — *Hisinger*. Lethæa Suecica, p. 77, pl. xxii, figs. 7 a, b, c, 1837.

TREBRATULA SACCULUS, *Von Buch*. Ueber Terebrat.; Akad. Berlin, 1834, p. 90 (not *T. sacculus*, Martin).

- ATRYPA DIDYMA, *Sow.* 'Silurian System,' pl. vi, fig. 4, 1839.
 TEREBRATULA CANALIS, *Id.* *Ib.*, pl. v, fig. 18, 1839.
 ATRYPA DIDYMA (including *T. canalis*), *Phillips and Salter.* Mem. Geol. Surv., vol. ii, p. 277, 1848.
 TEREBRATULA, — *Dav.* Bull. Soc. Géol. Fr., 2nd ser., vol. v, p. 326, pl. vi, fig. 7, 1848.
 SPIRIFER DIDYMUS, *Bronn.* Index Pal., p. 1176, 1848.
 HEMITHYRIS DIDYMA, *D'Orb.* Prodrome, vol. i, p. 37, 1849.
 ATRYPA CANALIS, *Id.* *Ib.*, p. 40, 1849.
 HEMITHYRIS DIDYMA, *McCoy.* Brit. Pal. Foss., p. 201, 1852.
 — UPSILON, *Id.* *Id.*, p. 207, 1852.
 WALDHEIMIA ? CANALIS, *Gray and Woodward.* Cat. Mollusca Brit. Mus., part iv, p. 77, 1853.
 SPIRIGERINA DIDYMA, *Schmidt.* Archiv Naturk. Liv- Ehst- und Kurlands, vol. ii, p. 210, 1858.
 RHYNCHONELLA — *Salter.* 'Siluria,' 2nd edit., pl. xxii, fig. 15, 1859.
 SPIRIGERA — *Lindström.* Öfv. K. Vet. Akad. Förhandl., p. 361, 1860.

Spec. Char. More or less pentagonal, usually longer than wide; posterior margins converging into a small tapering incurved beak; front narrowed, and emarginate or notched. Valves either regularly and moderately globose, or with a narrow mesial sulcus, commencing in each valve at a short distance from the extremity of the beaks, and extending to the front. No foramen visible. Interiorly, the spiral processes are directed outwards, and attached to the hinge-plate of the dorsal valve. Surface smooth, marked here and there by more or less strongly indented concentric lines of growth. Shell-structure impunctate. Two specimens measured—

Length 11, width 10, depth 7 lines.

„ 10, „ 10, „ 6 „

Obs. This small species has, since 1827, been referred to no less than nine different genera! Being possessed of spiral processes, it could not be classed with *Terebratula*, *Rhynchonella*, or *Hemithyris*; and it appears to me that its affinities are more with *Meristella* or *Athyris* than with any of the other genera to which it has been allotted. Palæontologists are also now generally of opinion that *Terebratula canalis*, *Sow.*, must be placed amongst the synonyms of the shell under description; and Mr. Salter and myself ascertained the matter beyond doubt by comparison of the original fragmentary valve upon which the so-termed *T. canalis* had been founded, the specimen being preserved in the Museum of the Geological Society. Von Buch was in error in placing it amongst the synonyms of *Terebratula sacculus*, these shells belonging to different genera; and therefore Bronn was right in stating that *Terebratula didyma*, Von Buch, was a different shell from *T. didyma* of Dalman. Not being acquainted with the *Terebratula corculum* of d'Eichwald, I cannot say whether Prof. Bronn was correct in referring it also to Dalman's species. I am not quite certain that the shell figured by Barrande as *Terebratula canalis*, *Sow.* (Silur. Brachiop. Böhmen, Pl. XVI, fig. 13), really belongs to Sowerby's

T. canalis or to Dalman's *T. (?) didyma*; and I think the valve attributed to *T. canalis* by M. de Verneuil in the great work on Russia (Pl. IV, fig. 11) must belong to another species. *Hemithyris upsilon* of M'Coy, from Pwllheli, appears to be *Meristella didyma*. [Salter.]

Meristella didyma varies in shape, as may be seen in the series of specimens figured in our Plate; but is always easily distinguishable from *M. tumida*, *M. angustifrons*, and *M. Circe*, on account of the furrow which in most specimens divides the valves into two distinct lobes. It has neither fold nor sinus.

Position and Locality. *Meristella didyma* occurs in the Llandovery, Wenlock, and Ludlow Rocks. In the Upper Llandovery at Glansevin, Llandeilo. In the Wenlock Limestone of Dudley. At Hay Head, Rushall Canal near Walsall, Benthall Edge, and Ledbury. Wenlock Shale of Falfield, Tortworth. In the Upper Llandovery of Eastnor Park, Malvern, and May Hill; and also at Pwllheli (as *Hemithyris upsilon*), according to Mr. Salter. At Usk, Abberley, and Sedgley, in the Aymestry Limestone. Ledbury, Herefordshire, in Wenlock Limestone. Messrs. Phillips and Salter found this shell at Ridge Hill, Abberley district, in Aymestry Limestone: South-west of Hazle and Wootton Farm (Woolhope district); at Llangibby; and North of Camp Wood in Aymestry Limestone; and at Dowlas in Lower Ludlow (Usk district). Cwm-craig-ddu, Upper Ludlow (Builth district). North of Trichrug. Storm Hill Lodge. Pont-ar-y Llechau, and Golden Grove, Dafaddfa-Uchaf, in the Llandeilo district. On the Continent it occurs at Ostergan, Gothland, at Solva (Ural), and in several localities in Oesel and Ehstland.

MERISTELLA NITIDA, *Hall* (sp.). Pl. X, figs. 28—32.

TEREBRATULA LEVIUSCULA, *Sow.* Sil. Syst., p. 631, pl. xiii, fig. 14, 1839.

ATRYPA NITIDA, *Hall.* Report Fourth Geol. District New York, pl. xii, fig. 5, 1843; and Palæont. New York, vol. ii, p. 268, pl. lv, figs. 1 a—o, 1852.

TEREBRATULA LEVIUSCULA, *Bronn.* Index Palæont., p. 1240, 1848.

— NITIDA, *Dav.* Bull. Soc. Géol. Fr., 2nd ser., vol. v, p. 327, pl. iii, fig. 37, 1848.

— — *De Verneuil.* Ibid., p. 346.

ATRYPA — *D'Orb.* Prodrome, vol. i, p. 40, 1849.

TEREBRATULA? LEVIUSCULA, *Salter.* Siluria, 2nd edit., pl. xxii, fig. 14, 1859.

RHYNCHONELLA NITIDA, *Id.* Ibid., p. 545, 1859.

SPIRIGERA? — *Lindström.* Öfv. K. Vet. Akad. Förhandl., p. 361, 1860.

Spec. Char. Shell small, ovate, longer than wide; valves almost equally convex; beak small, incurved over umbone of dorsal valve; no foramen observable; greatest width of shell about the middle, broadest anteriorly, tapering to the extremity of the beak. Valves almost equally and moderately convex; lateral and frontal marginal line

nearly straight. There is no regular fold or sinus, but a small depression sometimes exists at and near the front in the ventral valve. Surface smooth, marked by concentric lines of growth, more or less strong at intervals. Shell-structure impunctate. Two specimens measured—

Length 7, width 5, depth $3\frac{1}{2}$ lines.

„ 5, „ 4, „ 3 „

Obs. Having carefully examined and compared the original example of *Terebratula læviscula*, Sow. (in the Museum of the Geological Society), with the American *Atrypa nitida*, Hall, I soon became convinced that Sowerby's specimen was a small and obscure shell, with no definite characters, and therefore should not hold priority over Prof. Hall's well-determined species. Sowerby's specimen possesses the fibrous impunctate shell-structure of *Athyris* or of *Meristella*; and in one of these genera it will, no doubt, require to be classed. I am also somewhat uncertain whether the Bohemian *T. Circe* of Barrande be more than a variety of the shell under description; but, as there may exist still some uncertainty about the matter, and as I have not had the advantage of being able to examine many specimens of these shells, I will describe this last under a separate head, while repeating that our British examples attributed to Barrande's species seem to pass by so many gradations into *M. nitida*, that it is possible they are all variations of a single species. The only difference I can observe in the two is, that in *M. Circe* there appears to exist a small but deepish sinus towards the front in the dorsal valve of many specimens, which gives to the frontal line an elevated convex curve; but this is also visible, to a lesser degree, in many examples of undoubted *M. nitida*; and in his description of *Atrypa nitida*, Prof. Hall does not fail to observe that "the dorsal valve (our ventral) is sometimes marked, near the base, by a longitudinal depression." I had noticed the presence of spirals in 1847, and recorded the observation in the 'Bulletin Soc. Géol. France;' and Lindström has also detected them in a Gothland specimen. In his description of *A. nitida*, Prof. Hall observes:—"It is usually remarkable for its smooth surface, interrupted only by a few lines of growth on the middle or towards the base, the finer concentric striæ being obsolete or invisible to the naked eye. In some individuals the shell becomes thickened near the base [front], and marked by very strong lines of growth."

Position and Locality. *Meristella nitida* occurs in the Wenlock Limestone and Shale at the Rushall Canal near Walsall, at Dudley, Benthall Edge, at Tynewydd, Llan-doverly (the original locality), in Wenlock Shale. In Ireland it has been found by the Geological Survey in the Upper Silurian at Cahircorree, on the west side of County Kerry. It occurs also in Gothland. In America, according to Prof. Hall, it is found in every part of the Niagara group of New York State, being most abundant at Lockport; also at Wolcott, in Wayne County, &c.

MERISTELLA CIRCE, *Barrande* (sp.). Pl. X, figs. 33—35.

- | | |
|--------------------------------------|---|
| TEREBRATULA CIRCE, <i>Barrande</i> . | Sil. Brach. Böhm.; Nat. Abhandl., vol. i, p. 37, pl. xvi, fig. 6, 1847. |
| — — | <i>Dav.</i> Bull. Soc. Géol. Fr., 2nd ser., vol. v, p. 326, pl. iii, fig. 27, 1848. |
| SPIRIGERA — | <i>D'Orb.</i> Prodrôme, vol. i, p. 43, 1849. |
| ATHYRIS — | <i>Salter.</i> Siluria, 2nd edit., p. 542, 1859. |
| ? SPIRIGERA — | <i>Lindström.</i> Öfv. K. Vet. Akad. Förhandl., p. 361, 1860. |

Characters. Shell small, rhomboidal, longer than wide, greatest width about the middle, from whence it gradually tapers to the extremity of a small incurved beak, and anteriorly towards the front, which is much narrowed, and sometimes slightly indented. Valves almost equally and moderately convex, not often gibbous; margin-line nearly straight laterally, convex or curved in front. There is no real fold, but a small rounded elevation occurs near and at the front of the dorsal valve, with sometimes a small groove along the middle, and there is a corresponding depression or sinus in the ventral valve. Surface smooth, marked only by concentric lines of growth. Shell-structure fibrous, impunctate. Spiral processes attached to the hinge-plate of the dorsal valve. Two specimens measured—

Length 7, width 5, depth 4 lines.

" 6, " 5½, " 4 "

Obs. The spiral processes in this species (or variety) have been figured by Barrande and by myself, in 1847 and 1848.

Position and Locality. *Meristella Circe* occurs in the Wenlock Limestone of Dudley; at Hay Head, and the Rushall Canal near Walsall; in the Woolhope Limestone at Eastnor Park, Malvern, &c.

In Bohemia it was found by Barrande near Prague; and Lindström thinks he has obtained it at Gothland.

MERISTELLA ? MACLARENI, *Haswell*. Pl. XII, fig. 20, a, b.

- MERISTA MACLARENI, *Haswell.* Silurian Formation of the Pentland Hills, p. 30, pl. ii, fig. 16, 1865.

Spec. Char. Shell small, pentagonal, narrowed anteriorly, and slightly indented in front. Ventral valve much deeper and more convex than the opposite one, and with an angular sinus or sulcus extending along the middle. Beak pointed, much incurved over the umbone of dorsal valve, with sharply defined beak-ridges. No foramen visible. Dorsal

valve slightly convex, with a depression along the middle. Surface smooth, marked only by concentric lines of growth. Interior unknown.

Length 5, width 4, depth $2\frac{1}{2}$ lines.

Obs. Only one imperfect specimen having been found (by Mr. Haswell, in the Wenlock Shale of Deerhope Burn, Pentland Hills), I am much puzzled in which of two or three genera it should be located, and I have provisionally left it with *Meristella*; for, although several species of *Merista*, with the arched or shoe-lifter process occur in the Silurian rocks of Bohemia, I am not acquainted with any species of the genus in our British Silurian rocks, unless the small shell, Pl. XXI, figs. 28 and 29, may be referred to it.

MERISTELLA? *CRASSA*, *J. de C. Sow.* (sp.). Pl. XIII, figs. 1, 2, 3.

ATRYPA CRASSA, *Sow.* Sil. System, pl. xxi, fig. 1, 1839.

SPIRIFERA PERCRASSA, *M'Coy.* Brit. Pal. Foss., p. 194, 1852.

? *PORAMBONITES CRASSA*, *Morris.* Cat. Br. Foss., p. 143, 1854.

ATRYPA? — *Salter.* Siluria, 2nd edit., pl. ix, figs. 6, 8, 1859; Mem. Geol. Surv. Great Brit., p. 363, 1866; *Spirifera percrassa*, *ibid.*, p. 276.

Spec. Char. Longitudinally or transversely oval, somewhat sub-rhomboidal, widest about the middle; anteriorly the sides present a gentle inward curve, while the front is narrowed and slightly rounded; posteriorly the sides form broad convex curves, and the beak is small and incurved. Valves nearly equally convex (?) and smooth; a very slightly rounded lobe exists near the front in the dorsal valve, to which corresponds a small depression in the ventral valve. The interior of the latter is considerably thickened; while from under the extremity of the beak the dental plates diverge widely for a short distance on either side of the beak, and end anteriorly with a hinge-tooth, thus leaving between them a rather deep fissure, of which the sides slope inwards to unite along the bottom of the beak. On leaving the dental projections, these plates converge for some distance to diverge again, until they reach about two thirds or more of the length of the valve, so that towards the middle of the shell they partly surround the muscular area. These dental plates have not a great elevation, but are wide at their base. The lateral portion of the valve, between the dental plate and the margin, is exceedingly thick, and is marked by several obliquely indented grooves, which exist also, but with less depth, on the surface of the interior of this valve that is not occupied by the dental plates and muscular areas. In the interior of the dorsal valve a small hinge-plate is divided by a narrow groove; under this a slightly elevated median septum extends to about half the length of the shell, dividing the muscular scars, which form a pair on either side of the

septum, and are separated one from the other by smaller oblique ridges. Two specimens measured—

Length 12, width 11 lines.

„ 8, „ 9 „

Obs. This shell does not appear to have been well understood by those who have described it, nor can the genus to which it belongs be yet with certainty determined. It is not a *Spirifer*, as Prof. McCoy and one or two others have supposed it to be; for, besides the interior arrangements not being those of that genus, it possesses no area; the lateral portions of the beak being regularly rounded off from the margin of the fissure. The fissure itself is also in a great measure filled up by the incurved beak or umbone of the dorsal valve. Then there appears no sufficient or valid grounds that I can perceive for placing it with *Porambonites*, nor with *Atrypa*; and consequently the genus to which it bears most affinity would appear to be *Meristella* or *Athyris*. At p. 230 of 'Siluria' (2nd edit.) Mr. Salter states that *Atrypa crassa* is probably of the same genus as the so-called *Rhynchonella angustifrons*, and that *Terebratula furcata*, Sow. (Min. Conch., Pl. 21, fig. 16), one of the same group, is an Upper Llandovery species. Now, I have already shown that the so-called *Hemithyris* or *Rhynchonella angustifrons* of McCoy and Salter is either a *Meristella* or an *Athyris*, and is possessed of spiral lamellæ for the support of the oral arms, as in those genera; and consequently it is highly probable that *Meristella crassa* was similarly provided.

My description of the interior is taken from gutta-percha moulds, made from internal casts; but, as casts alone have been hitherto found, I will here reproduce the description Prof. McCoy has given of them—"Casts of the receiving (ventral) valve show two very strong slits of the dental lamellæ, converging so as to meet in the rostral part, enclosing the large triangular foramen, and again diverging in their anterior part, reaching to within one fourth the length of the anterior margin: each side with about six thick radiating ridges (ovarian?), and two or four on the middle lobe, all obscurely forking at the margin. Casts of entering (dorsal) valve show two thick diverging dental pits at the beak, a wide shallow mesial depression, with an obscure crucial arrangement of four angular ridges defining the muscular impressions."

I have not myself seen a perfect bivalve specimen of this common species, and the figures given in the 'Silurian System' are very imperfect. Although I have not been able, from want of sufficient material, to offer complete figures of the exterior, I believe those I have given of the interior may be considered an improvement on those hitherto published, and will assist the student in any further researches he may make with reference to the species.

Position and Locality. *Meristella crassa* is common in the Lower Llandovery, and rare in the Upper Llandovery or May Hill rocks. Mr. J. de C. Sowerby describes it from Cefn Rhyddan, Llandovery. Mr. Salter mentions it from the Upper Llandovery rock of Bogmine, near Shelve; and from the Lower Llandovery of Cyru-y-brain, and of

Mathyrafal, near Meifod, North Wales, from which last place Prof. M'Coy also quotes it. He also states that it has been also found in the green conglomerates (Lower Wenlock) of Moel Seisiog, Llanrwst, Denbighshire (but Mr. Salter refuses to acknowledge it as a Wenlock species).

MERISTELLA ? FURCATA, *Sow.* (sp.). Pl. XIII, figs. 7, 8, 9.

TEREBRATULA FURCATA, *J. de C. Sow.* Sil. Syst., pl. xxi, fig. 16, 1839.

RHYNCHONELLA — *Morris.* Cat. Brit. Foss., p. 146, 1854.

— — *Salter.* Siluria, 2nd edit., p. 545, pl. ix, fig. 12, 1859.

Spec. Char. Shell small, elongate-oval; ventral valve convex, smooth, beak incurved; interior much thickened, while from under the extremity of the beak the dental plates diverge widely for a short distance, and terminate anteriorly with a hinge-tooth; from thence they again converge for a short distance, leaving between them a deep concave space or fissure. At the anterior base of this hollow two deep grooves commence, and gradually diverge; while a raised central ridge divides them for some distance, to become itself afterwards divided into two branches, with a depression between them towards the front. There exist also in the thickened lateral portions of the valve two or three oblique furrows, all of which are in relief in the casts—

Length $4\frac{1}{2}$, width 4 lines.

Obs. Of this species I am unfortunately acquainted with some internal casts of the ventral valve only; and all my efforts to obtain a specimen showing the exterior of both valves, as well as the interior of the dorsal valve, have proved unavailing. Therefore our knowledge of this species, and of its true generic position, must for the present be necessarily very incomplete and unsatisfactory. I have left it provisionally with *Meristella*, as suggested by Mr. Salter, who has seen many specimens in working over the collections of the Geological Survey; but it may require to be removed hereafter, when the other parts of the shell shall have been discovered. In the mean time I have given carefully enlarged drawings of the interior of the ventral valve. Mr. J. de C. Sowerby describes his shell as "Orbicular, very convex, smooth; beak of one valve much curved; interior marked with several furrows, and a forked channel in the middle." This is the aspect of the cast; the forked channel being the cast of the divided central ridge. (See above.)

Position and Locality. This species has been obtained from the Upper Llandovery sandstone, one and a half mile south of Bogmine, Shelve, Shropshire. In the Survey Museum are some specimens found by Mr. Salter at Morrell's Wood, near the Wrekin. Sir R. Murchison's original specimens may be seen in the Museum of the Geological Society. It is, says Mr. Salter, a common species.

MERISTELLA? SUBUNDATA, *M'Coy* (sp.). Pl. XIII, figs. 4, *a*, *b*, *c*.

HEMITHYRIS SUBUNDATA, *M'Coy*. Brit. Pal. Foss., p. 207, pl. i n, 1852; and Annals Nat. Hist., 2nd series, vol. viii, p. 394, 1851.

RHYNCHONELLA — *Salter*. Siluria, 2nd edit., p. 545, 1859.

HEMITHYRIS — *Schmidt*. Archiv Naturk. Livlands, &c., vol. ii, p. 214, 1858.

Spec. Char. "Transversely broad-oval; valves almost equally convex; beak very small, apical angle 140° near the apex; lateral margins straight; front raised into a rounded wave, from which in the large valve a wide shallow mesial depression extends half-way to the beak, with a corresponding elevation in the small valve in some specimens extending to the beak." Length 11, width 15 lines.

Obs. I have reproduced Prof. M'Coy's diagnosis and figures, as he had greater opportunity of studying the shell than I have had; but I have ventured to remove it from *Hemithyris*, as its affinities appear to me to tend more towards those of the *Athyridæ* than to the *Rhynchonellidæ*, of which the term *Hemithyris* is no more than a synonym. In this alteration I am supported by Mr. Salter, who has devoted so much attention to the British Palæozoic genera and species. The shell is smooth, and remarkable for the smallness of its beak. It is not much unlike some compressed examples of *Meristella tumida*.

Position and Locality. It is stated to be very common in the schists and limestones of Mathyrafal, South of Meifod, Montgomeryshire; also in the slate of Alt-ffair-flynnon, Llanfyllin; and at p. 545 of 'Siluria' it is quoted from the Llandovery rocks. At p. 275 of vol. iii of the 'Memoirs of the Geological Survey,' its locality is more exactly given by Mr. Salter as Pen-y-craig, Llangynyw, near Mathyrafal, Meifod, North Wales (in the Lower Llandovery). Prof. F. Schmidt mentions having found this species in the Lower Silurian of Baltischport.

Genus *ATHYRIS*, *M'Coy* (= *SPIRIGERA*, *D'Orbigny*).

For the characters of this genus readers are referred to my 'Monograph of British Permian Brachiopoda,' p. 20, &c., and to the 'Devonian Monograph,' p. 113, &c.

Although the genus *Merista* proper, with its shoe-lifter-shaped plate, is represented abundantly in the Upper Silurian rocks of Bohemia, I am not (as before said) at present acquainted with any British Silurian species that I could refer to that genus.

ATHYRIS OBOVATA, Sow. (sp.). Pl. XII, fig. 19; and Pl. XIII, figs. 5, 5 a.

ATRYPA OBOVATA, Sow. Sil. Syst., pl. viii, fig. 9, 1849.

TEREBRATULA — Sow. ? *Barrande*. Silur. Brach. Böhmen, p. 28, pl. xv, fig. 8, 1847.

— — *Dav.* Bull. Soc. Géol. France, 2nd ser., vol. v, p. 327, 1848.

ATRYPA — *Phillips and Salter*. Mem. Geol. Surv., vol. ii, pt. 1, p. 278, 1848.

ATHYRIS? — *Salter*. Siluria, 2nd edit., p. 542, pl. xxii, fig. 16, 1859.

Spec. Char. Almost circular, a little wider than long; valves nearly equally convex, with or without a small rounded elevation or fold near the front in the dorsal valve, to which corresponds a small depression in the ventral valve; beak small, incurved over the umbone of dorsal valve; surface smooth, or rather marked by concentric and slightly raised lines of growth.

Length 5, width $5\frac{1}{2}$, depth $3\frac{1}{2}$ lines.

Obs. All my efforts to obtain a sight into the interior of the dorsal valve of this species have proved unsuccessful; but I feel almost certain that it was provided with spiral lamellæ. I have received from Dr. Holl the interior of the ventral valve, of which a figure will be found in Pl. XIII. British examples of this shell are small, and do not attain the dimensions of the specimen figured from Bohemia by Barrande. I am also not certain whether the species under description and *Atrypa compressa*, Sow., should not be considered as a single species. It is true that Sowerby informs us that in his *A. obovata* there exists a small marginal elevation at the front in the dorsal valve, forming a rounded sinus in the ventral; but, although this may be the case in some specimens, it was not so in many examples that have fallen under my notice, so that I am very much inclined to regard them as one species, or as varieties only;¹ but as this does not appear to be the view taken by the generality of palæontologists, I shall provisionally leave them under separate heads. They present the same dimensions; but *A. compressa* is stated to be equivalve, and *A. obovata* to be inequivalve.

¹ In the 'Annual Report of the Trustees of the Museum of Comparative Zoology,' Boston, 1863, Mr. Louis Agassiz states that "The differences noticed among animals of the same species do not constitute varieties, but are individual differences, similar to those which may be noticed among the different individuals of the same family among ourselves. Any attempt to group them under a few heads, as varieties, fails as soon as large numbers of specimens are considered. What have been generally described as varieties by naturalists are extreme individual differences, occurring more frequently in certain species than in others; but, like all others, presenting the same indefinite peculiarities, which forbid one considering them as in any way typical. This shows that individuality constitutes the most prominent feature of the organic kingdom, and is by no means confined to the human family."

Position and Locality. It occurs plentifully in the Lower Ludlow rock at Mathon Lodge, west flank of Malverns; also at Dog Hill, Ledbury. The type specimen of this species, as well as that of *A. compressa*, Sow., may be seen in the Museum of the Geological Society of London.

M. Barrande found this species near Prague, in Bohemia.

ATHYRIS COMPRESSA, Sow. (sp.). Pl. XII, figs. 16—18.

ATRYPA COMPRESSA, Sow.	Sil. Syst., pl. xiii, fig. 5, 1839.
— — M'Coy.	Syn. Sil. Foss. Ireland, p. 39, 1846.
? TEREBRATULA, —	Barrande. Silur. Brach. Böhmen, p. 47, pl. xiv, fig. 3, 1847.
— —	Dav. Bull. Soc. Géol. France, 2nd ser., vol. v, p. 327, 1848.
RHYNCHONELLA —	Salter. Siluria, 2nd edit., p. 544, pl. xxii, fig. 22, 1859.
? SPIRIGERA —	Lindström. Öfvers. K. Vet.-Akad. Förhandl., p. 361, 1860.

Spec. Char. Shell small, orbicular, somewhat transversely oval or circular; valves moderately and nearly equally and evenly convex, rather compressed, without fold or sinus; front line slightly rounded on the margin; beak in ventral valve very small, and much incurved over the umbone of the opposite valve, so that the minute aperture is but rarely exposed. Surface smooth, marked more or less deeply with concentric, slightly projecting lines of growth; shell-structure fibrous, not punctured.

Length $5\frac{1}{2}$, width 6, depth 3 lines.

Obs. I have stated my reasons above (p. 121) for thinking that this and *A. obovata* may probably belong to a single species. In one or two examples a shallow or slight median depression was observable near the front, as may be noticed in a specimen from Dudley, in Gray's collection, British Museum (fig. 17). Although I have not been able to examine the interior of any of our British examples, it is very probable, if not certain, that the animal was provided with spiral lamellæ for the support of its oral arms; and if the specimen figured by M. Barrande from Bohemia be really referable to the shell under description, we possess positive evidence of their occurrence. Mr. Salter, at p. 544 of 'Siluria,' 2nd edit., places *A. compressa* in the genus *Rhynchonella*; and at p. 542 *A. obovata*, doubtfully, in *Athyris*. I think, however, that they both belong to the same genus, if not to the same species.

Position and Locality. *A. compressa* occurs in the Wenlock limestone near Dudley, and the Woolhope limestone at Woodside and Nash, Presteign; also in the Upper Silurian (Wenlock) shales of Hare Hill, in the Pentland Hills. In Ireland M'Coy thought he obtained it from the Lower Silurian schists of Tirmaskea, Pomeroy, Co.

Tyrone, but Mr. Salter assumes that this is a mistake, and that *A. compressa* is strictly Upper Silurian. On the Continent M. Barrande found the species in Upper Silurian rocks near Prague. Dr. G. Lindström is not quite certain if it really occurs at Gothland.

ATHYRIS ? *DEPRESSA*, *Sow.* (sp.). Pl. XII, figs. 11—15; and Pl. XIII, fig. 6.

ATRYPA DEPRESSA, *J. de C. Sow.* Sil. Syst., pl. xiii, fig. 6, 1839.

TEREBRATULA DEPRESSA, *Dav.* Bull. Soc. Géol. France, 2nd ser., vol. v, p. 327, 1848.

ATRYPA — *Phillips and Salter.* Mem. Geol. Surv., vol. ii, part 1, p. 277, 1848.

RHYNCHONELLA — *Salter.* Siluria, p. 544, pl. xxii, fig. 17, 1859.

HEMITHYRIS — *M'Coy.* Brit. Pal. Foss., p. 201, 1852.

SPIRIGERINA CORDATA, *Lindström.* Öfvers. K. Vet.-Akad. Förhandl., p. 363, pl. xii, fig. 3, 1860.

Spec. Char. Transversely obovate, widest anteriorly; front nearly straight; dorsal valve varying in degree of convexity, but deeper than the opposite valve; mesial fold of moderate width, very slightly raised above the general convexity of the valve, and divided by a central longitudinal sulcus; the lateral portions of the valve sloping rapidly to the margin, which in front is slightly incurved. On each of the lateral portions of the valve there exist two or three obscurely marked ribs or undulations. Ventral valve moderately convex, with a wide shallow sinus, extending from the extremity of the beak to the front, along the middle of which runs a small longitudinal rib, two or three rounded ribs being also present on the lateral portions of this valve. Beak pointed, small, and incurved, with a narrow triangular opening under its extremity, but rarely visible, owing to the incurvation of the beak. Lateral portions of the valve depressed towards the margin, which is sharp and slightly sigmoid. Surface of valves marked with concentric lines of growth. Shell-structure fibrous, not punctured.

Length 5, width $6\frac{1}{2}$, depth 3 lines.

Obs. This little species differs much in appearance under the varied conditions in which it is found. Usually it occurs either in the state of imperfectly preserved internal casts, or with only the inner layers of its shell still adhering to the internal mould. In this condition it was described and represented by Mr. J. de C. Sowerby in the 'Silurian System,' and thus it appears, too, in Pl. XII, fig. 13, of this Monograph. In this state the slightly raised ribs of the perfect shell are rarely observable, the casts being obscurely marked with radiating lines, or by two or three furrows along the middle, as described by Sowerby; while the perfect shell (of which I have seen but two or three examples) is as described in our diagnosis: carefully enlarged illustrations of it will be found in Pl. XIII, fig. 6. The internal cast of the dorsal valve (Pl. XII, fig. 15 a) shows well the four adductor or occlusor muscular scars, with a deep depression between the posterior pair; and these are somewhat similar in their arrangement to those

we have figured in an internal cast of the same valve of *Athyris ambigua* ('Monogr. Carbonif. Brach.,' Pl. XVII, fig. 14). It is, however, with considerable hesitation that I group this shell with *Athyris*, as we are still too little acquainted with its internal arrangements, and M'Coy and Salter may be correct in placing it with *Rhynchonella*. It varies also considerably in depth, some specimens being much depressed, while others are more or less gibbous.

Lindström informs me that his Swedish *Spirigerina cordata* will require to be placed among the synonyms of the shell under description; the Gothland specimens that I have seen are, however, in the cast, more strongly striated than our own.

Position and Locality. The shell occurs plentifully in the Wenlock shale of Stump's Wood, and in the Woolhope limestone, on the road between Affrick and Crew's Hill, Malvern; also at Delves Green, near Walsall. Prof. M'Coy has noted it as being abundant in the Bala limestone; but this is erroneous, the young shell of a Lower Silurian *Orthis* being the form referred to (Salter).

On the Continent it has been found in the island of Gothland.

Genus—RETZIA, King.

Ref. King, 'Monograph of Permian Fossils,' p. 137, 1850.

Generic Char. Prof. King describes his genus as "a Spiriferida in general oval longitudinally, ribbed or striated, with large punctures; *large valve* foraminated at or near the apex of the umbone, with a triangular area and closed fissure. Type, *Terebratula Adrieni* (De Verneuil). This interesting genus, well distinguished by the above characters from other *Spiriferidæ*, embraces some pretty species, such as *Retzia Baylei* (*Terebratula*, Davidson), *R. Bouchardii* (*Terebratula*, Dav.), *R. Oliviani* (*Terebratula*, Vern.), and *R. Salteri* (*Terebratula*, Dav.). *Terebratula ferita* and some other Spirigerous *Terebratulæform* species," &c. King, therefore, takes as the type of his genus *Retzia Adrieni*, a Spanish Devonian shell, described and figured by de Verneuil in the 'Bull. Soc. Géol. France,' 2nd series, vol. i, pl. xiv, fig. 11; and by myself in Pl. VI of my "General Introduction." *R. Oliviani* is also a Spanish Devonian shell, figured likewise in the same French plate above mentioned; but none of these shells, nor the others above alluded to, possess "a triangular area and closed fissure." *Retzia Adrieni* is longitudinally oval, costated, with the beak truncated by a small circular foramen, partly margined by a deltidium in two pieces.

In an interesting article on the genus *Retzia*, published in the 'Sixteenth Report of the Regents of the University of the State Cabinet of New York,' p. 53, 1863, Prof. J. Hall remarks that, in regard to the entire character and limitations of this genus, there still exist some doubt and difference of opinion amongst palæontologists, and that he has consequently considered it desirable to propose a different arrangement of the species formerly grouped in the genus *Retzia*; that for such shells as *R. serpentina* (*Terebratula*,

De Koninck) a Carboniferous form, with a small hinge-area, as well as for *Retzia vera*, Hall, and some others, he would retain the generic designation of RETZIA; while for certain forms which, according to his views, have more nearly the characters of *R. Adrieni*, he proposes the new generic designation of TREMATOSPIRA (types, *T. perforata* and *T. multistriata*, Hall). For those species typified by *R. formosa*, Hall, *R. Bouchardii*, Dav., and *R. Salteri*, Dav., he would propose the genus RHYNCHOSPIRA.¹ He concludes his notice on the genus *Retzia* by observing that his remarks have been made more with the intention of calling the attention of palæontologists to the characteristics observed in several species than of finally determining the question of the generic relations among the several groups.

I am quite ready to allow that Prof. King's diagnosis is defective, since, as above stated, none of his several types possess "the triangular area and closed fissure;" but, for all that, we are bound to consider *T. Adrieni* as the type of the genus, and, if necessary, to alter the defective portions of the diagnosis. *R. serpentina*, it is true, was rightly or wrongly added by myself, Dr. S. P. Woodward, and some other palæontologists to the species of *Retzia*, on account of its small hinge-area and punctured shell; and consequently, if Prof. Hall can show that its characters are distinct from those of *R. Adrieni*, it would require to form the type of a new genus. *Retzia* would therefore be a *Terebratula-shaped shell, with a small circular foramen at or near the extremity of the beak, more or less completely surrounded by a deltidium in two pieces. Surface ribbed or striated. Shell-structure punctate. Interior with diverging spiral lamellæ.* Types, *R. Adrieni*, *R. Salteri*, *R. Bouchardii*, &c. It is a Palæozoic genus as far as we at present know; but much has still to be found out with reference to its internal arrangements, as well as whether the small hinge-area of *R. (?) serpentina* and *R. vera* would of itself afford sufficient grounds for the establishment of a separate genus.

RETZIA SALTERI, Davidson. Pl. XII, figs. 21, 22.

TREBRATULA SALTERI, Dav. Bull. Soc. Géol. France, 2nd ser., vol. v, p. 331, pl. iii, fig. 31, 1848.

RETZIA SALTERI, Schmidt. Sil. Form. Ebstland, &c., p. 212, 1858.

— — Salter. Siluria, 2nd edit., p. 250, Foss. 57, fig. 7, 1859.

— BAYLEI, Lindström. Gotlands Brachiop.; Öfers. K. Vet.-Akad. Förhandl., p. 337, 1860.

Spec. Char. Transversely oval or sub-pentagonal, wider than long, greatest breadth posteriorly; hinge-line very obtuse; sides rounded, indented at the middle in front.

¹ Prof. Hall writes me, that, while describing his genus *Trematospira*, he had forgotten to refer to my *Rhynchonella Salteri*, and that his American types of *Trematospira* have two very little ribs in the middle of the valve, as in *Rh. Salteri*, and that he now feels at a loss whether or no to refer to *Terebratula ferita* as the type of *Retzia*.

Valves almost equally convex; beak small, much incurved and truncated by a small circular foramen, partly margined by a very short deltidium in two pieces. Dorsal valve convex and ornamented with from ten to sixteen angular ribs, of which the two central ones are much smaller or narrower than those which occupy the lateral portions of the valve, and are also at a slightly lower level. Ventral valve ornamented in a similar manner; but a deepish narrow sinus, commencing at the extremity of the beak, extends to the front, with one, two, or three small longitudinal ribs along the middle. The surface of each valve is crossed by numerous concentric raised lines, and covered with small asperities due to numerous short hollow spinules. In the interior of the dorsal valve spiral lamellæ, for the support of the oral arms, are attached to the hinge-plate.

Length 6, width 7, depth 5 lines.

Obs. In 1848 I described, under the designations of *Terebratulæ Salteri*, *T. Baylei*, and *T. Bouchardii*, shells which de Verneuil, Alcide d'Orbigny, and myself, then considered to present differences sufficiently marked to make it desirable to maintain them as separate species. Mr. Salter and Dr. Lindström have since considered *R. Salteri* and *R. Baylei* to belong to a single species. In their view my two friends are possibly correct; but it will be desirable to point out the reasons which in 1848 induced both de Verneuil and myself to separate them.

R. Salteri is wider than long, and ornamented with strong prominent angular ribs, and with four smaller longitudinal ribs along the middle portion of the dorsal valve. Of these the two central ribs are the narrowest; these four ribs forming a very slightly raised mesial fold. In the sinus of the opposite valve there is usually a narrow central rib, with another larger one on each side, while the ribs on the lateral portions of the valve are much larger and more prominent. Now, in *R. Baylei* the shell is smaller, and either as wide as long or longer than wide; and it has but one small central rib in the dorsal valve, and two corresponding ribs in the ventral. *R. Bouchardii* is larger than the two preceding shells, and has many more and comparatively smaller ribs on the lateral portions of the valves; while in the dorsal valve there exist four very narrow central ribs, and three corresponding ribs in the sinus of ventral valve, but of these the median rib is by far the narrowest. These details will be better understood by a glance at the figures; but the difference which struck me most in 1848, and still does now, is that, while in *R. Salteri* and *R. Bouchardii* the extremity of the beak is truncated by a small circular foramen, partly margined by a deltidium, in *R. Baylei*, on the contrary, the beak was entire as in *Rhynchonella*, with a small circular foramen under its angular extremity, entirely margined by a deltidium. Smaller differences we also observed in the comparative number of concentric lines, as well as in the proportions of the spinules with which the surface was covered.¹ It is very possible that these differences may be only

¹ Dr. Carpenter, who has at my request kindly examined the shell-texture of this species, states that it has the true *Terebratuline* perforations, large and distinct, all over the shell. It agrees in this respect with *Retzia*.

those of individuals ; but as I could not satisfy myself that such was really the case, it will be better provisionally to describe *R. Baylei* and *R. Bouchardii*, if not as separate species, at least as subspecies or varieties.

Position and Locality. Abundant in the Wenlock limestone of Sedgley, Wenlock Edge, and Benthall Edge ; Dudley ; at Hay Head, near the Rushall Canal, Walsall ; Malvern and May Hill ; and in the Ludlock rocks near Llandeilo.

It has also been found in the Island of Gothland by Lindström, and at Lode, Kasti, Sandel, Kaugatoma-Pank, Ohhesaare-Pank, &c., in the Baltic Provinces, by Prof. F. Schmidt.

Var. *R. BAYLEI*, *Davidson*. Pl. XII, figs. 23, 24, 25, and 27.

TEREBRATULA BAYLEI, *Dav.* Bull. Soc. Géol. France, vol. v, 2nd ser., p. 330, pl. iii, fig. 29, 1848.

RETZIA SALTERI, var. BAYLEI, *Salter*. Siluria, 2nd edit., p. 250, Foss. 57, fig. 8, 1859.

Circular, or a little longer than wide, greatest width about the middle ; sides rounded, very slightly indented in front ; valves almost equally convex ; beak small, pointed, incurved, with the foramen situated under its angular extremity, and margined by a deltidium in two pieces. Valves ornamented with from eleven to fifteen ribs, of which the central one in the dorsal valve is by far the narrowest, while two small ribs extend along the narrow sinus in ventral valve. Valves crossed by concentric lines, and minute spinular asperities cover the surface. Two specimens measured—

Length 4, width 4, depth 3 lines.

„ 4, „ 5, „ 4 „

Position and Locality. It is common in the Wenlock limestone in all the localities in which *R. Salteri* occurs, and is most likely a dwarfed variety of that shell.

Var. ? *R. BOUCHARDII*, *Davidson*. Pl. XII, figs. 26, 28—30.

TEREBRATULA BOUCHARDII, *Dav.* Bull. Soc. Géol. France, vol. v, 2nd ser., p. 332, pl. iii, fig. 38, 1848.

RETZIA — *Salter*. Siluria, 2nd edit., p. 250, Foss. 57, fig. 4, 1859.

Transversely or elongated oval ; sides rounded, slightly indented in front. Valves almost equally convex ; beak in the ventral valve small, incurved, and truncated by a small circular foramen, partly margined by a short deltidium in two pieces. Valves ornamented with from twenty-one to twenty-nine small angular ribs, of which the two or four central ones in the dorsal valve are much smaller or narrower than those on the lateral portions of the valve, and they occupy a slightly lower level. In the ventral valve

there is a median longitudinal sulcus occupied by one or three smaller ribs. Surface of valves closely and regularly crossed by concentric equidistant lines, and very minute spinules cover the surface of the shell. Two specimens measured—

Length 8, width 7, depth 6 lines.

„ 6, „ 7, „ 4

Position and Locality. It is rare in the Wenlock limestone of Dudley; more abundant at Rock Farm, Longhope, whence very fine examples were procured by the late Rev. J. Dyson, of Malvern.

RETZIA ? BARRANDII, *Davidson*. Pl. XIII, figs. 10—13.

TEREBRATULA BARRANDII, *Dav.* Bull. Soc. Géol. France, vol. v, 2nd ser., p. 332, pl. iii, fig. 32, 1848.

RHYNCHONELLA — *Salter*. Siluria, 2nd edit., p. 250, Foss. 57, fig. 6, 1859.

RETZIA — *Id.* Ib., p. 544.

— *Lindström*. Gottlands Brach.; Öfvers. K. Vet.-Akad. Förh., p. 337, 1860.

Spec. Char. Shell small, almost circular, or slightly elongated oval; ventral valve very convex; beak small, incurved, and truncated by a small foramen, partly margined by a deltidium in two pieces; surface ornamented with six large rounded ribs, of which the two central are the most elevated, and are separated by a median concave sulcus. Dorsal valve very slightly convex posteriorly, almost flat and even depressed in the middle anteriorly; lateral margins rounded and undulating, slightly truncated in front. Surface ornamented by seven rounded ribs, of which the central one is on a little lower level than those on either side. The valves are also regularly crossed by concentric lines or ridges of growth. Interiorly spiral lamellæ for the support of oral arms are attached to the hinge-plate of the dorsal valve. Two specimens measured—

Length 4, width 4, depth 3 lines.

„ 3½, „ 3, „ 2 „

Obs. This elegant little shell is easily distinguishable from other British Silurian Brachiopoda. It has been considered by myself and others as one of the few Silurian forms *incertæ sedis*; but recently some light has been thrown upon the subject by the discovery made by Dr. Lindström and myself of portions of the spiral coils, which appear to agree in position with those of *Retzia*. Dr. Carpenter has also at my request microscopically examined the shell-structure, and writes—“The specimen of *Retzia? Barrandii* which you enclosed must have been stamped on in the Post-office; for it came to me in powder. However, this powder was very useful to me, for it enabled me to pick out a number of transparent natural lamellæ, the examination of which went to confirm what I had previously made by sections from the specimens you had sent me some days before. The general texture of the shell of *R. Barrandii* is rather Rhynchonelline than Terebratuline, the two types being

distinguished by the facility with which the shell of the former cleave into thin lamellæ (see p. 20 of my Chapter in your General Introduction). Large portions of it are entirely destitute of perforations; and a cursory examination might readily lead to the conclusion that the shell is entirely imperforate; but the careful examination of sections taken in different directions shows that there are bands of *very minute* perforations opening along the *sides* of the costæ; and although I have not been able to distinguish their orifices when looking at the surface of the shell by reflected light, yet the appearances presented by sections leave no doubt in my own mind that they traverse the entire thickness of the shell. I do not say that these characters show that the shell is not a *Retzia*; but they would suggest a careful examination of its other characters; since, as the very interesting case you give of the so-termed *Pentamerus carbonarius* of McCoy additionally shows, all the supposed anomalies in regard to punctuation disappear before a thorough investigation of internal structure.”—(London, 22nd November, 1866).¹

Position and Locality. *Retzia Barrandii* occurs abundantly in some few localities, such as in the Wenlock Limestone or Shale at Hay Head, near Walsall, near Dudley; and at Buildwas near Wenlock; also at the base of the Wenlock Shale in Malvern Tunnel; and in the Woolhope Limestone of the same locality (J. W. S.).

It is also found in the Island of Gothland by Dr. Lindström.

Genus—*ATRYPA*, *Dalman*, 1827 (SPIRIGERINA, *D'Orbigny*).

Ref.—Davidson, ‘General Introduction,’ p. 90. (Type, *Atrypa reticularis*, LINN.)

The characters belonging to this genus have been so often described by myself and other palæontologists that it will not be necessary to refer to them again in this Monograph.

ATRYPA RETICULARIS, *Linné* (sp.). Pl. XIV, figs. 1 to 22.

ANOMIA RETICULARIS, *Linné*. Syst. Nat., ed. xii, p. 1152, 1767.

TEREBRATULA PECTINATA, *Bruguière*. Hist. Nat. Vers. Test.; Encyl. Méth., pl. 242, fig. 4, 1789.

TEREBRATULITES ASPER, *Schloth.* Leonhard's Taschenbuch, p. 74, pl. i, fig. 7, 1813.

— *PRISCUS*, *Id.* Petref., p. 262; Nachtr., pl. xvii, fig. 2; pl. xx, fig. 4, 1820.

— *EXPLANATUS*, *Id.* Nachtr., pl. xviii, fig. 2, 1820.

ANOMITES RETICULARIS, *Wahlenberg*. Nov. Act. Soc. Upsal., vol. viii, p. 65, 1821.

¹ Prof. Hall, to whom I had sent specimens of our *R.* (?) *Barrandii*, informs me that he believes it to be referable to his genus *Cælospira* (Hall, 1863, ‘Sixteenth Report on the State Cabinet,’ p. 60; Type, *C. concava*=*Leptocalia concava*; Family, *Spiriferidæ* ?); but that he has some doubt whether he should now make *Zygospira* (Hall, 1862, generic descrip., ‘Fifteenth Report on the State Cabinet,’ p. 154; Type, *Z. modesta*, Say, sp.; Family, *Spiriferidæ*) distinct, they being all small shells, and difficult to manipulate.

- TEREBRATULA AFFINIS, *Sowerby*. Min. Con., vol. iv, p. 324, fig. 2, Jan., 1822.
 ATRYPA RETICULARIS, *Dal.* Vet. Akad. Verhandl., p. 127, pl. iv, fig. 2, 1827.
 — ASPERA, *Id.* Vet. Ak. Handl., p. 128, pl. iv, fig. 3, 1827.
 TEREBRATULA ASPERA, *Def.* Dict. vol. liii, p. 164, 1828.
 — CANCELLATA, *Eichw.* Zoologia Specialis, vol. i, p. 276, pl. iv, fig. 11, 1829.
 PORAMBONITES MAXIMA, *Pander*. Beiträge zur Geol. Russl., p. 16 B, fig. 7, 1830.
 ATRYPA RETICULARIS, var. ALATA, *Hisinger*. Bidrag till Sveriges Geognosi, part v, p. 120, pl. iii, fig. 4, 1831.
 TEREBRATULA PRISCA, *Von Buch*. Ueber Terebr., p. 71, 1834.
 — RETICULARIS, *Bronn*. Leth. Geog., p. 72, pl. ii, fig. 10, 1837.
 ATRYPA RETICULARIS, *His.* Lethæa Suecica, p. 75; and var. β *alata*, *ibid.*, pl. xxi, figs. 11 a—e, 1837.
 TEREBRATULA PRISCA, *Pusch.* Polens Palæont., p. 26, 1838.
 — — *Von Buch*. Mém. Soc. Géol. France, vol. iii, pl. xvi, fig. 19, 1838.
 ATRYPA AFFINIS, *Sow.* Sil. Syst., pl. vi, fig. 5, 1839.
 — ASPERA, *Id.* *Ib.*, pl. xii, fig. 5.
 — ORBICULARIS, *Id.* *Ib.*, pl. xix, fig. 3.
 TEREBRATULA PRISCA, *Von Buch*. Beiträge zur Geol. Russl. 17, 58, 66, 1840.
 — ARMIGERA, *Id.* Von Buch, Beiträge zur Geol. Russ., p. 108, 1840.
 ATRYPA PRISCA, *Phillips*. Palæoz. Foss., p. 33, fig. 135, 1841.
 TEREBRATULA RETICULARIS, *Murch.* Vern. and Keys. Russia and Ural, p. 91, pl. x, fig. 12, 1845.
 — — *Barrande*. Sil. Brach. Böhmen, p. 95, tab. xix, figs. 8, 9, 1847.
 ATRYPA — *J. Hall*. Palæont. New York, vol. ii, pp. 72 and 270, pl. xxiii, 1851.
 — — *S. P. Woodward*. Manual of the Mollusca, p. 228, 1854.
 TEREBRATULA PRISCA, *Eichw.* Sil. Syst. in Ebstl., p. 141, 1858.
 ATRYPA RETICULARIS, *Salter*. Siluria, 2nd ed., pl. xxi, figs. 12, 13, 1859.
 SPIRIGERINA — *Lindström*. Gottlands Brachiop., p. 362, 1860.
 ATRYPA — *Dav.* Monogr. Brit. Dev. Brach., p. 53, pl. x, figs. 3, 4, 1864 [as well as in the English, French, and German editions of the General Introduction].

[Many more references might be added, but those given comprise the most important Silurian names; and to extend the list would be unnecessary: for Devonian synonyms, see p. 53 of my Devonian Monograph.]

Spec. Char. Shell oblong-ovate, or transverse; widest near the hinge; beak small, acute, very little produced, and generally pressed to the umbone of the dorsal valve, so that the small circular foramen situated under its incurved extremity is rarely perceptible. Dorsal valve uniformly convex and gibbous, especially so at the umbone and along the middle, sloping gradually to the margin; hinge-line extended into compressed ears, with or without any defined fold. Ventral valve very slightly convex posteriorly, or from the extremity of the beak to about the middle of the valve, whence it becomes gradually and slightly concave towards the lateral portions of the valve, with sometimes a deepish sinus near the front; sides of shell rounded, frontal marginal line more or less raised into

a rounded wave. Surface of valves covered with numerous, small, radiating, rounded, irregularly bifurcating ribs, which increase in width and number towards the margin, and are separated from each other by concave sulci of rather less width; the valves are also crossed at greater or less intervals by numerous foliated expansions, rising from the surface of the valve and projecting in different specimens from two lines to nearly an inch from the surface and margin of the valves. On these foliated expansions the rounded ribs and concave interspaces, which occur upon the valves, are regularly continued. Shell-structure fibrous and impunctate. In the interior of the dorsal valve is a divided hinge-plate, supporting two broad spirally coiled lamellæ; spires vertical, closely appressed and directed towards the disk of the valve. A largish specimen, with its foliated expansions, measured—

Length 26, width 31 lines.

Obs. At page 54 of my Devonian Monograph this species has been described at some length, and to that work the student is referred for details respecting muscular and other impressions. We will now add some further remarks in connection with the Silurian specimens. First of all, with reference to the specific name, let me observe that naturalists appear to be now very generally agreed that the single specific denomination of *reticularis*, given by Linné, in the Twelfth Edition of his ever-memorable 'Systema Naturæ,' should replace some nine or ten other names subsequently given to modifications of this very variable and far-spread species. Linné informs us that his shell is heart-shaped, and marked with decussate striæ; the shorter (dorsal) valve more gibbous than the other; and the beak of the flat valve slightly prominent. He moreover refers us for a description and figure to p. 88, Pl. V, fig. 5, of his 'Musæum Tes-sinianum' (published in 1753); but I must confess that it would be difficult to recognise the *Anomia reticularis* in the two badly drawn figures given of the shell in question. The description, however, is somewhat more to the point.¹

At page 65 of his memoir entitled 'Petreficata Telluris Succanæ,' in the eighth volume of the 'Nova Acta Regiæ Societatis Scientiarum Upsaliensis,' published in 1821, Wahlenberg gives a short description of the shell under discussion;² and a perfectly recognisable figure of the Linnæan shell will be found in Pl. 450, fig. A, 8, of Martin Lister's 'Historia sive Synopsis Methodica Conchyliorum,' &c., published in 1688.

¹ "β. *ANOMIA* subrotunda striis longitudinalibus viginti. Tab. v, fig. 5.

Testa subrotunda, parum compressa, striis longitudinalibus. Figs. 20, 21.

Valvula superior antice in medio convexa, emarginata. Valvula inferior, natice in medio depressa, elongata, adscendens umbonum alter postice prominet."

² "β. *Anomites reticularis*, superficie reticulata (vel decussatim nervata), valvulis undique æquabiliter convexis, brevior convexiore, Gmel. Syst. Nat., i, p. 3343 (excluso Synon. Linnæano et *A. plicatellam pertinente*). Fischer, Program. de Terebrat., p. 31, n. 19, t. iii, fig. 5. Schroet., Abhandl., vol. ii, t. iii, figs. 11—14. Frequenter in Gothlandia occurrit. Superficie margaritacea splendente insignis: impressiones autem in Schisto superiore Westrogothiæ passim conspiciuntur." No one, I think, could recognise in Fischer de Waldheim's figure the *Anomites reticularis* of Linnæus.

As we have already remarked, this shell is extremely variable in the number of its longitudinal striae, as well as in that of the number and length of its concentric foliaceous expansions. At the request of Prof. Edward Forbes, Mr. Baily counted the ribs, &c., in no less than 117 specimens; and it would appear that the number in different specimens, old and young, varied from ten to sixty, but that the transverse fringes did not augment in number in a similar ratio to the number of ribs.

To one of the varieties with fewer and larger ribs the designation of *Aspera* has been applied; but both Hisinger, in 1831, and Lindström, in 1860, agree in considering this last as a variety of *A. reticularis*, differing only in shape; Lindström observing, at the same time, that the Linnean form varies, *like all those species which possess an extended horizontal and vertical distribution* (E. Forbes). In Gothland he finds coarse-ribbed specimens of *A. reticularis* similar to those that occur in the Devonian formation; but these variations are connected with the finely ribbed varieties by every possible gradation and intermediate shape; and the same occurs in Great Britain.¹ In Plate XIV I have endeavoured to represent some of the principal shapes assumed by this shell, and have given illustrations of the interior of both valves, as well as of its internal casts; and in Plates X and XI of my 'Devonian Monograph' will be found additional figures, completing the external and internal details we now possess in connection with this species. M. Barrande, in his valuable 'Monograph of the Silurian Brachiopoda of Bohemia,' p. 95, describes two varieties of *A. reticularis* as var. *Verneuiliana* and var. *Murchisoniana* (op. cit., Pl. XIX, figs. 8, 9). Both these modifications in shape occur in our Silurian rocks. Fig. 4 of our plate is the var. *Murchisoniana*; while figs. 6 and 7 represent the var. *Verneuiliana*.

Position and Locality. *Atrypa reticularis* ranges from the Lower Llandovery to the Upper Devonian; the greatest range known of any Palæozoic shell. It occurs in so many places, that several pages could be filled, were it necessary to enumerate all those with which we are acquainted. It is particularly abundant in the Llandovery and Wenlock rocks. In England it is plentiful in the Wenlock Limestone and Shales at Dudley, Wenlock Edge, and Walsall, in various localities in the Malvern, Woolhope, May Hill, Usk, Llandeilo, and Marloes districts, which will be found recorded at p. 278 of Phillips and Salter's memoir, in the second volume of the 'Memoirs of the Geological Survey of Great Britain.' It is not uncommon in the Upper and Lower Ludlow rocks; and abounds, of large size, in the Aymestry Limestone. Thus, it occurs at Ridge Hill, Walgrove Hill, Martley Road, Collin's Green, in the Abberley district. At Backbury

¹ In describing this species at p. 198 of his 'British Pal. Fossils,' Prof. McCoy states: "It varies firstly, in the convexity of the valves, both as to degree, distance from the beak (at which it is greatest), and equality; some small varieties, and the young at all times, having the valves almost equally and evenly convex; secondly, in form, some, particularly the young and the small varieties, being nearly orbicular; others being elongate, and nearly triangular, from the width of the hinge-line and narrowness of the front; thirdly, in the number, thickness, and closeness of the ridges, and the scales which cross them, both of which are often smaller and closer than in the typical variety."

Camp, Shucknall Hill, &c., in the Woolhope district. At Llanbadoc, near Radyr, the Darren, Cefn Ila, &c., in the Usk district, &c. The Rev. J. D. Latouche has found beautiful examples, with the spiral lamellæ silicified, in the Aymestry Limestone, near the Craven Arms, in the Ludlow district. It occurs also in the Woolhope Limestone at Littlehope; in the Upper Llandovery Sandstone of May Hill and Huntley Hill; at the Hollies Farm, Shropshire; and in all the Lower Llandovery grits and shales of South Wales it is everywhere abundant, but it is never found lower down in the Caradoc rocks (Salter).

In Scotland it is common in the Wenlock Shales of the Pentland Hills, and in various localities in the Girvan district, Ayrshire, in Upper and Lower Llandovery rocks.

In Ireland it occurs at Ferriter's Cove, in beds of Wenlock and Ludlow age; also at Carrigonough, County of Wexford, which must, therefore, be a "Llandovery" locality (Salter).

On the Continent it is a common fossil in Norway, near Christiania; in Gothland; in various parts of Russia, as far as the frontier of Siberia; in Bohemia, and in several other parts of Europe. It has also been found in China, and in very many places in the United States, Canada, Newfoundland, &c.; and in Devonian times it ranged to Australia, and to the extreme northern points reached by Arctic explorers (Salter, 'Brit. Assoc. Reports').

ATRYPA MARGINALIS, *Dalman* (sp.). Pl. XV, figs. 1, 2.

- TEREBRATULA MARGINALIS*, *Dalman*. Kongl. Vet. Akad. Handl., p. 143, pl. vi, fig. 6, 1827, &c.
 — — *Hisinger*. *Lethæa Suecica*, p. 81, pl. xxiii, fig. 8, a, c, 1837.
 — — *J. de C. Sow.* Sil. Syst., pl. xii, fig. 12, 1839. (*T. imbricata* in the lists.)
 — — *Dav.* Bull. Soc. Géol. France, 2nd ser., vol. v, p. 331, 1848.
SPIRIGERINA — *M'Coy*. Brit. Pal. Foss., p. 197, 1852.
 — *IMBRICATA*, *Schmidt*. Sil. Form. Ebstland, &c., p. 212, 1858 (but Prof. Schmidt refers to Sowerby's figure, pl. xii, fig. 12, which is referable to *T. marginalis*).
ATRYPA MARGINALIS, *Salter*. Siluria, 2nd edit., p. 542, pl. xxii, fig. 19 (the upper figures only), 1859.
SPIRIGERINA — *Lindström*. Gottlands Brachiop., pp. 362, 363, 1860.

Spec. Char. Transversely sub-pentagonal, or almost elliptical; hinge-line nearly straight; lateral margin rounded, very slightly so in front; beak of ventral valve small, straight, moderately incurved, with a circular foramen under its extremity, and distinctly separated from the umbone or hinge-line of dorsal valve by a deltidium in two pieces, almost entirely surrounding the aperture. Dorsal valve moderately convex and trilobed; mesial fold extremely narrow at first, and suddenly widening, slightly elevated, flattened along the middle, and sharply separated from the lateral portions of the valve by a deepened groove. The fold is also often abruptly bent upwards close to the frontal edge.

Ventral valve almost flat, or very slightly convex near the beak, with a rather deep and sharply defined sinus, margined on either side by a prominent ridge, while the lateral portions of the valve are gently concave, and vertically turned up at their extremity; lateral margins undulating; front margin abruptly raised, straight along the middle; surface of both valves ornamented with numerous small bifurcating ridges or ribs, of which every three or four are clustered together, and separated by more deeply indented grooves. The shell is also closely crossed by numerous, equidistant, small, concentric, slightly raised lines. Interiorly the spires are vertical, closely adpressed, and directed towards the disk of the valve.

Length 8, width 9, depth 5 lines.

Obs. With the exception of Dr. Lindström, palæontologists have united under a single species the *Terebratulæ marginalis* of Dalman and *T. imbricata* of J. de C. Sowerby; still, as pointed out by Lindström, they would appear to be distinguished by several well-marked characters, which may be briefly enumerated. In *Atrypa marginalis* the beak is straight and prominent, though small, with a circular foramen under its slightly incurved extremity, distinctly separated from the hinge-line by a well-defined deltidium. In *A. imbricata*, on the contrary, the beak is so much incurved as to almost touch the umbone of the opposite valve; consequently no deltidium is observable; the extremity of the beak is pierced by a small foramen. This last-named shell has also both its valves more convex than those of *A. marginalis*; and the external sculpture, or rather the concentric ridges, are very different in the two shells. In *A. imbricata* they are close, numerous, small, and but little produced; while in *A. marginalis* they are coarse and scale-like: but a glance at the respective enlarged figures of both forms, given in Pl. XV, will explain these differences much better than words can. *Atrypa marginalis* was well described by Dalman in 1827;¹ and his figures, although not well executed, show the principal characters of the species. Dr. Lindström observes, moreover, in his valuable memoir on Swedish Silurian Brachiopoda, that *A. marginalis* differs from *A. imbricata* by its more flattened and expanded shape, and that the typical form is in some localities represented by a variety with few and coarser ribs, bifurcating several times. Although in the 'Silurian System' Sowerby described and figured both shells as separate species, in the 'Tabular List' appended to the same work he considers the two as synonyms of a

¹ "T. testa radiatim multistriata, margine compresso apiceque subreflexo; valva majore dorso canaliculata; rostro prominente recto, foramine parvo apicali.

Locus: Gottlandia, in Klinteberg; Mus. Dom. Hisinger.

Specimina majora longit. 18 lat. 20 m.m.

Testa undique confertim longitudinaliter striata vel subsuleata, costis 40—50; videlicet nonnullis apicem versus furcatis; de cætero inequalis, margine compresso, sæpius sub-explanato, interdum reflexo.—Valva minor jugo dorsali parum elevato, striato, margine apicali sinuato, L. submarginato.—Valva major canali dorsali profundo striato, apice sinuato; rostrum acutiusculum, prominens, rectum, foramine parvo subapicali.—Valvulæ minoris prima basis subrostrum occultata, nate haud manifesta."

The figure is, however, much too finely striated.

single species, giving accidental priority to his own designation, while he distinguishes his true *T. imbricata* by the name *T. imbricata*, var. *abbreviata*.

Position and Locality. The exact vertical range of this species has not yet been satisfactorily determined; and it is uncertain whether it is as extended as that known for *A. imbricata*. Mr. Salter says that the typical form is a common Caradoc fossil. He finds it in North and South Wales, and in Ireland in Bala shales and limestone. It has, however, been determined by Salter from the Lower and Upper Llandovery rocks of many localities, especially in the Lower at Rhyader, Llandovery, Matherafal, Mandinam, Welshpool, Haverfordwest, Devil's Bridge, Duffryn Castle, &c.; and in the Upper Llandovery at Llandovery and Chirbury. It is also found plentifully in the Wenlock Limestone; at the Wren's Nest, Dudley; Hay Head, near Walsall; at Wenlock Edge; and Benthall Edge, &c.; in the Wenlock rocks near Carmarthen, Llandeilo, and Pen-y-lan; also in the Woolhope Limestones of Malvern, Presteign, and East of Walsall. Abroad it occurs in Gothland.

ATRYPA IMBRICATA, *J. de C. Sow.* (sp.). Pl. XV, figs. 3—8.

TEREBRATULA IMBRICATA, *Sow.* Sil. Syst., pl. xiii, fig. 27, 1839.

— *MARGINALIS*, *Barrande.* (*T. marginalis* in the description; *T. imbricata* in the explanation of plate), Silur. Brach. Böhmen., p. 79, pl. xix, fig. 10, 1847.

ATRYPA IMBRICATA, *Salter.* Siluria, 2nd edit., pl. xxii, fig. 19, (the lower figures only). [Here *A. imbricata* is regarded as a variety only of *A. marginalis*.] 1859.

SPIRIGERINA — *Lindström.* Gottlands Brachiop., p. 362, 1860.

Spec. Char. Almost circular, often as wide as long, frequently almost globular; sides and front rounded; beak of ventral valve small, much incurved over, and almost touching the umbone of opposite valve, perforated at its extremity by a small circular foramen; the deltidium being completely concealed; beak-ridges strongly marked. Dorsal valve often gibbous, mesial fold rounded, and at times considerably elevated, especially near the front. Ventral valve convex, divided by a deep sinus; front raised into a rounded wave. Surface of valves ornamented with numerous angular, branching, or bifurcating ribs, more or less clustered together, so as to give to the surface an undulating appearance. The valves are also crossed by many projecting undulating laminæ of growth, which overlap each other to a considerable extent. Interiorly two broad coiled lamellæ are attached to the hinge-plate, with vertical spires, closely adpressed, and directed towards the disk of the valve. Two specimens measured—

Length 8, width 8, depth 6 lines.

„ 10, „ 11, „ 8 „

Obs. In the preceding description are given details in connection with this species

which need not be here repeated. Dr. Lindström informs us that to a variety of this species Prof. Lovén has given the MS. name of *lamellosa*.

Position and Locality. *Atrypa imbricata* ranges from the Caradoc beds up to the Wenlock Limestone. It is common in the Wenlock Limestone at the Wren's Nest, Dudley, at Benthall Edge, Wenlock Edge, Hay Head, near Walsall, Woolhope, &c. At Haverfordwest in Lower Llandovery beds; at Guilsfield, north-west of Welshpool, in the Upper Caradoc; in the Bala beds of Keisley, near Dufton, in Westmoreland. In Scotland it occurs in the Caradoc (?) of Penhill. In Ireland at Killee, Pomeroy, and the Chair of Kildare, in Caradoc or Bala Limestone. Many more localities might be given; but as some confusion has taken place from the mixing of the two species, those localities only where the shell is positively known to occur are here recorded.

It occurs in Gothland; and Prof. Schmidt states in his memoir already mentioned that *A. imbricata* occurs in the Lower and Upper Silurian rocks of the Baltic Provinces. It was also found in Bohemia by M. Barrande, in Étage E.

ATRYPA? HEMISPHERICA, J. de C. Sow. Pl. XIII, figs. 23—30.

<i>ATRYPA HEMISPHERICA,</i>	<i>Sow.</i>	<i>Sil. Syst.</i> , p. 637, pl. xx, fig. 7, 1839.
—	—	<i>M'Coy.</i> <i>Syn. Sil. Foss. Ireland</i> , p. 39, 1846.
<i>TREBRATULA</i>	—	<i>De Verneuil.</i> <i>Bull. Soc. Géol. France</i> , 2nd series, vol. iv, p. 654, 1847.
<i>ATRYPA</i>	—	<i>Phillips and Salter.</i> <i>Mem. Geol. Surv. Great Britain</i> , vol. ii, part 1, p. 277, 1848.
—	—	<i>Salter.</i> <i>Quart. Journ. Geol. Soc.</i> , vol. vii, p. 172, 1852.
—	—	<i>Hall.</i> <i>Palaont. New York</i> , vol. ii, p. 74, pl. xxiii, fig. 11 a, g, 1852.
<i>HEMITHYRIS</i>	—	<i>M'Coy.</i> <i>Brit. Pal. Foss.</i> , p. 201 (also var. <i>Scotica</i> , p. 202), 1852.
<i>ATRYPA</i>	—	<i>Salter.</i> <i>Siluria</i> , 2nd edit., p. 100, fig. 4, and pl. ix, fig. 3, 1859.
<i>LEPTOCHELIA</i>	—	<i>Hall.</i> <i>Report of the Regents of the University of the State Cabinet of New York</i> , p. 33, 1857, and <i>Pal. New York</i> , vol. iii, p. 448, 1859.
<i>ATRYPA</i>	—	<i>Salter.</i> <i>Mem. Geol. Surv.</i> , vol. iii, p. 36, 1866.
<i>LEPTOCHELIA</i>	—	<i>Billings.</i> <i>Catalogue of the Silurian Fossils of the Island of Anticosti</i> ; <i>Geol. Surv. of Canada</i> , p. 48, 1866.

Spec. Char. Shell small, sub-orbicular, usually wider than long; ventral valve sub-hemispherical, evenly convex; beak small, pointed, incurved, with a foramen beneath it. Dorsal valve very nearly flat and orbicular, slightly depressed along the middle; sides rounded; frontal margin a little deflected. Hinge-line very obtuse, nearly as long as the breadth of the shell; with rounded cardinal angles. Surface of each valve ornamented with from twelve to eighteen simple rounded or sub-angular ribs, with concave interspaces

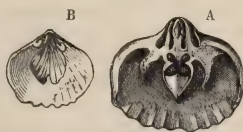
of about equal width; the valves are crossed at intervals by sharp concentric slightly raised undulating lines.

Length 5, width 6, depth $2\frac{1}{2}$ lines.

Obs. Sowerby describes this pretty little species as a beautiful fan-like shell, easily recognisable by its convex ventral, and almost flat dorsal valve. In Great Britain it occurs chiefly in the condition of external impressions and internal casts. The *cast* of the flattened dorsal valve shows an elongated slit, for a tooth, on each side of the beak between which a small triangular cardinal boss extends to a short distance, with deeper pits on either side. At the base of this prominence commences a well-pronounced distinct median sulcus, which extends to about half the length of the valve (indicating in the shell the presence of a small median ridge); and on either side of the sulcus may be seen two impressions referable to the adductor or oclusor muscle. In the convex cast of the ventral valve on either side of the beak there exists a short diverging slit (produced by the dental lamina), and a little further on the pits left by the teeth. The muscular impressions are obscurely indicated.

At p. 202 of his 'Brit. Palæoz. Foss.' Prof. M'Coy states, "As some modern writers have referred this shell to the genus *Orthis*, I have taken great pains to ascertain the characters of the hinge, as the obvious absence of the puncturing in the tissue of the shell rendered the reference to *Orthis* very doubtful in my mind; and I have convinced myself that there is no cardinal area whatever, but that the beak of the entering (dorsal) valve is simply pointed, hollow, and so much incurved only as to leave a wide triangular foramen beneath it; the hinge-characters, therefore, warrant the placing this singular shell in *Hemithyris*, with which also its tissue is identical."

Prof. Hall and Mr. Billings place *Atrypa? hemisphaerica* of Sowerby in the first-named author's genus *Leptocælia*; and although it is very probable that the shell is neither an *Atrypa*, *Terebratula*, nor *Rhynchonella* (*Hemithyris*), and that we have not yet obtained a permanent home for it, still, as the interior of the species is imperfectly known, and we have no positive certainty that it was similar to that of *Leptocælia flabellites*—the type of Hall's genus—it will, I think, be more prudent to follow Messrs. J. de C. Sowerby, Salter and others, in leaving it for the present with *Atrypa*. Having made moulds in gutta-percha from a number of internal casts of the dorsal valve of specimens from the May Hill Sandstone of Ankerdine, obligingly collected for me by Dr. Holl, and where the species occurs by millions under the condition of external impressions and internal casts, I am able to detect several differences from what we observe in the cast of the same valves of *Leptocælia flabellites*, and which I will endeavour to describe. In the inside



Leptocælia flabellites, after J. Hall's figures.
A. Interior of the dorsal valve, showing the cardinal process, crura, and crural plate, restored from cavities seen in a cast.
B. Interior of the ventral valve.

of the dorsal valve of *L. flabellites* there exists a large prominent cardinal process, and on either side the inner socket ridges occupy a lower level. In the same valve of *Atrypa ? hemispharica*, on the contrary, instead of a large cardinal process there exists a small pit or depression, the inner socket-ridges projecting on either side, while the sockets themselves are likewise much smaller, and there is no evidence of the existence of crura or a loop as described to be present in *Leptocælia flabellites*. In *A. ? hemispharica* a blunt median ridge commences under the pit already described, and extends to about half the length of the valve; while on either side may be sometimes seen the scars left by the adductor or oclcluser muscle. I have also observed differences in the interior of the ventral valve of the shell under description and that of *L. flabellites*. It will, therefore, I think, be desirable to ascertain whether *A. hemispharica* was possessed of crural processes and a loop before placing it in the new genus *Leptocælia*; and in order to assist the reader in the researches he may feel disposed to make on the subject, I will in a foot-note transcribe the description Prof. Hall has given of his genus.¹ His figures are copied at page 137.

¹ Genus—*LEPTOCÆLIA*, Hall. Regents' Report on the State Cabinet, p. 67, 1857, and Pal. New York, vol. iii, p. 447, 1859. Type—*L. flabellites*, Conrad, sp., *Terebratula* and *Rhynchonella*, in part, of authors. *Atrypa*, Conrad, Hall, &c.

"Shell inequivalved, variable in form, usually semioval or subcircular, transverse or elongate, plano-convex, or concavo-convex; hinge-line sometimes equal to the greatest width of the shell. Ventral valve convex or subangular in the middle, with beak more or less extended, moderately incurved: foramen terminal, the lower side formed by two deltidial pieces; dorsal valve flat or concave, or depresso-convex. A mesial fold and sinus usually existing, but not often prominent. Structure of shell lamellose or fibrous, not punctate.

"Valves articulating by means of two strong teeth in the ventral, inserted into sockets in the dorsal valve, which are mainly excavated in the base of a strong cardinal process; teeth converging, denticulate with corresponding denticulations in the sockets. Muscular impressions marking a large oval or flabelliform area, with a thin median septum; adductor imprints small.

"The dorsal valve is marked by a strong cardinal process, at the base of which, on either side, are the deep oblique dental fossets; and from the inner margins of these proceed the crural processes, supported below by thickened plates which extend obliquely for a short distance towards the middle of the shell bordering the muscular impressions. The muscular impression forms a suboval space divided through the middle by a low median septum. The crura, in their extension, are united in a flattened disk, which terminates at its remote extremity in an acute point; and on the centre of the cardinal side of the disc there is a slender process extending downwards, while near the junction of the crura with the disc there is, on each side, a slender descending process continued into the cavity of the ventral valve. The cardinal process, in its central portion, is thickened at first and divided in the middle, but, in old shells, gradually filling the passage to the foramen, and sometimes by a prominent point in the centre entirely dividing the passage. The hinge-line is often much extended, and in the dorsal valve nearly straight to the cardinal angles. There is sometimes the appearance of a false area on the ventral valve, somewhat similar to *Atrypa*, the margin being thickened and grooved; but this does not appear to be a characteristic or constant feature. The specimens of the interior, which have fallen under my observation, usually preserve only the short crural processes; and it is in one specimen alone, which is partially filled with crystalline matter, that distinct cavities can be seen corresponding with what I have described (see figure p. 137). The

I am by no means convinced that Prof. Hall is correct in considering the *Terebratula ? lepida* of Goldfuss to be a type of his genus, and we know that another exceedingly compressed shell, *Atrypa (Orthis) lens*, Phillips (*T. dividua*, Schnurr), was possessed of spiral appendages (see Schnurr's work on the Devonian Brachiopoda of the Eifel, pl. xxiv, fig. 2); and, indeed, as stated by Prof. Hall himself, the internal characters of his genus have been determined mainly from the interior of *L. flabellites*; and, consequently, until a further investigation into the interior dispositions of the other mentioned types has been effected, I would not venture to adopt as conclusive the generic identification proposed for our Silurian shell.

Position and Locality. This shell appears to be characteristic of the Upper, and to be more rarely found in the Lower Llandovery beds: it is exceedingly abundant in certain localities. In the "Silurian System" it is mentioned from Ankerdine Hill, Abberley district; Worcester Beacon, Malvern. I have seen it from May Hill and Huntley Hill, in the May Hill district. It covers large surfaces at Charfield Green, and Damory Hill, Michaelswood-Chace, Gloucestershire; Tortworth; Merrick Wood, near Much Wenlock; and Wooltack Bay in the Marloes district.

In addition to these localities, in the 3rd vol. of the 'Memoirs of the Geological Survey,' Prof. Ramsay and Mr. Salter mention Llandeilo, Llangadock, Builth, Presteign, Longmynd, Church Stretton, Norbury, Chirbury, and Malvern, in the Upper Llandovery rocks.

In Scotland it is exceedingly plentiful in rocks of the Llandovery age, at Saugh Hill; Lower Thrave, and Braes, in sandstone; at Ardmillan in a blue limestone, &c., all in the Girvan district, Ayrshire.

For Ireland Prof. M'Coy mentions the following localities:—In calcareous shales at Ardaun, Cong, Co. Galway. Very common in the sandstone of Blackwater Bridge, Leenane; Boocaun, Cong; Cappacorcogue, Cong; Glencraff; Kilbride, &c., all in the County of Galway, and in Upper or Lower Llandovery rocks.

In America Prof. Hall states it to be very abundant in the upper green shale crystalline matter was first deposited upon these internal organs, which have subsequently almost entirely decomposed, leaving in the cavities fragments of the substance showing the original form of the crura and appendages.

"The shells of this form have been described as *Terebratula*, and more recently have been included with *Rhynchonella*, from which they differ conspicuously in the great inequality of the valves and the extension of the hinge-line, as well as in their internal structure. I have, therefore, referred to this genus the *Leptocalia (Atrypa) disparilis* of the Niagara group, the *Terebratula lepida* of Goldfuss. The *T. sublepida* and *T. Duboisii* of Murchison, de Vern., and de Keyserling (Geol. of Russia and the Ural Mountains). The *L. concava* and *L. imbricata*, in the Lower Helderberg group, are analogous forms which have been referred to this species.

"The *Atrypa hemispherica* of Murchison is apparently a characteristic form of this genus, as well as *A. planoconvexa*, both from the Clinton group. The internal structure, however, has been determined from the species of the Oriskany Sandstone and Lower Helderberg specimens, but mainly from the former."

(Clinton group) at Rochester; near the Ridge Road in Ontario; at Central's Mill, and Sodus and Wolcott in Wayne County. In some beds it forms thin calcareous layers in which the shells preserve a beautiful silvery lustre, as it does in the Tortworth district. M. de Verneuill refers to the vast abundance of this shell both in Europe and in America. Mr. Billings states it to occur in the Middle Silurian at South-west Point, the Jumpers, and East Point in the Island of Anticosti.

ATRYPA? SCOTICA, *M'Coy* (sp.). Pl. XIII, fig. 31.

ATRYPA HEMISPHERICA, *Sow.*, var. SCOTICA, *M'Coy*. *Salter*, Quart. Journ. Geol. Soc., vol. vii, p. 178, pl. ix, fig. 12, 1851.

HEMITHYRIS — var. SCOTICA, *M'Coy*. *Brit. Pal. Foss.*, p. 202, pl. i, II, fig. 10, 1852.

Spec. Char. Shell small, transversely sub-orbicular, wider than long, or elongated oval. Ventral valve moderately and evenly convex; beak small, pointed, and incurved. Dorsal valve very slightly convex, with a small longitudinal depression along the middle. Sides and front rounded. Surface of each valve ornamented with from about twenty to twenty-five small narrow ribs, usually bifurcated, the valves traversed by concentric lines of growth. Two specimens measured—

Length 5, width 6, depth 2 lines.

„ 6, „ 5½, „ 2 „

Obs. Prof. M'Coy himself suggests that “this may ultimately prove a distinct species, in which case the varietal name may become specific.” He points out that it is distinguished from the type species (*A. hemispherica*) by the ribs being more numerous (usually about twenty to twenty-four), considerably narrower, less prominent, and less regular in size and distinctness, and *often irregularly forked*; a character seldom or never seen except at the inner edge of the flat valve in the typical specimens. The receiving (ventral) valve is also slightly more carinate, and the entering (dorsal) valve not so perfectly flattened, and with a faint trace of a wide undefined, mesial hollow.” Having examined a very great number of specimens of true *A. hemispherica*, as well as of *A. Scotica*, I have preferred to retain them as distinct: in the first the ribs are fewer in number and simple, while in all the specimens of the second that have come under my notice they were, as the Professor says, much more numerous, narrower, and bifurcated. The question with reference to the genus may, however, still remain undetermined.

Position and Locality. It occurs in vast numbers in the greenish Lower Llandovery sandstone of Mullock Quarry, above Dalquharan, near Girvan, Ayrshire.

ATRYPA? GRAYII, Davidson. Pl. XIII, figs. 14—22.

TEREBRATULA GRAYII, Davidson. Bull. Soc. Géol. France, 2nd ser., vol. v, p. 331, pl. iii, fig. 33, 1848.

RHYNCHONELLA — Salter. Siluria, p. 250, Foss. 57, fig. 3, 1859.

SPIRIGERINA? — Lindström. Gottland's Brachiop., p. 364, 1860.

Spec. Char. Shell small, transversely oval, irregular, and abruptly twisted, from one half of the shell being more elevated than the other. Valves almost equally convex without fold or sinus, but with a median depressed line only; beak of ventral valve small, moderately incurved, and truncated by a minute circular foramen, which is separated from the hinge-line by a small narrow deltidium in one piece; beak-ridges sharply defined, leaving between them and the hinge-line a narrow triangular area. Surface ornamented by concentric ridges, from which rise narrow (frill-shaped) projecting laminae, longitudinally plaited. Interior not known; excepting the cardinal process in the dorsal valve.

Length 5, width 7, depth 3 lines.

Obs. This strangely shaped shell, of which I have seen about forty specimens, does not appear to have exceeded the dimensions above given, and is generally much smaller. It constantly assumes the same character, that is to say, having always its right or left half twisted higher or lower than the other; and consequently both valves are longitudinally divided along the middle by a sharply curved line. When well preserved, the surface exhibits a variable number of rows of projecting concentric laminae, as in *Atrypa reticularis*, but much narrower; the surface is smooth in worn specimens only. It is well known that some species of *Rhynchonella*, and of other genera, at times or even normally assume a similarly twisted appearance. My endeavours to procure specimens showing internal characters have proved fruitless; and I cannot therefore determine exactly the genus. It is evidently not a *Terebratula*, for its shell is fibrous and impunctate; its surface-ornament is not that of a *Rhynchonella*. Lindström has placed it (with a mark of interrogation) in *Atrypa* (*Spirigerina*), where we may provisionally leave it. The hinge and cardinal process are peculiar; the last projecting considerably, as seen in fig. 21. Whether or not it possessed spiral lamellæ is uncertain.¹

Position and Locality. *Atrypa*? *Grayii* has been hitherto found in the Wenlock Limestone only. It occurs at Hay Head, near Walsall; some rare specimens have also been procured near Dudley.

Dr. Lindström finds it at Wisby, in the Island of Gothland, and there it appears to be rare.

¹ Prof. Hall, to whom I sent specimens of this species, thinks that spires will be ultimately found; but that it is neither a *Rhynchonella*, an *Atrypa*, nor an *Athyris*, though it may be allied to the latter; it is so different from any American forms.

FAMILY—RHYNCHONELLIDÆ.

Genus—PENTAMERUS, *Sowerby*, August, 1813.

For the description of this genus, see the "General Introduction," 'Monograph of British Fossil Brachiopoda,' vol. i.

PENTAMERUS KNIGHTII, *Sow.* Pl. XVI, figs. 1—3; Pl. XVII, figs. 1—10; Pl. XIX, fig. 3.

PENTAMERUS KNIGHTII, *Sow.* Min. Conch., vol. i, p. 73, pl. xxviii, August 1st, 1813.

- AYLESFORDII, *Sow.* Ibid., pl. xxix, 1813.
- KNIGHTII, *Id.* Sil. Syst., p. 615, pl. vi, fig. 8, *a, b, c*, 1839.
- — *F. A. Rømer.* Verstein. Harzgebirges, pl. v, fig. 16, 1843.
- — ? *Barrande.* Naturwiss. Abhand., vol. i, p. 107, pl. xxi, fig. 3, 1847.
- — *Dav.* Bull. Soc. Géol. France, 2nd ser., vol. v, p. 333, 1848.
- — *Phillips and Salter.* Mem. Geol. Survey, vol. ii, part 1, p. 292, 1848.
- — *Bronn.* Index Pal., p. 944, 1848.
- — *D'Orb.* Prodrome, vol. i, p. 41, 1849.
- — *F. A. Rømer.* Beitr. Geol. Kenntniss d. nord-westl. Harzgebirges, p. 59, 1850.
- — *M'Coy.* Brit. Pal. Foss., p. 209, 1852.
- — *Gruenewalt.* Verst. Silurisch. Kalkstein von Bogosslowsk; Mém. Sav. Étrang., vol. vii, p. 26, pl. iv, fig. 15, 1854.
- — *S. P. Woodward.* Manual of the Mollusca, p. 228, fig. 143; pl. xv, fig. 22, 1854.
- — *Morris.* Cat. of Brit. Foss., p. 142, 1854.
- — *De Verneuil.* Geol. of Russia, vol. ii, pl. vii, fig. 1, 1845.
- — *C. Giebel.* Silur. Fauna d. Unter-harzes, p. 46, 1858.
- — *Salter.* Siluria, 2nd edit., pl. xxi, fig. 10; and var. *Aylesfordii*, fig. 11, 1859.
- — *Billings.* Canad. Journ., p. 59, fig. 90, 1861.
- — *Salter.* Explanat. Sheets, 160, &c., Geol. Surv. Ireland, p. 13, 1863.

Spec. Char. Shell impunctate; ovate, or longitudinally oval, sometimes obscurely pentagonal, and as wide as long; more rarely transversely oval and wider than long; the young form at times trigonal. Ventral valve ventricose or more convex than the opposite one, evenly rounded or flattened along the middle; beak large and very much

incurved, fissure triangular, commencing under the extremity of the beak, and extending to the hinge-line; no area or deltidium. The lateral portions of the beak merge gradually into the edge of the fissure; beak-ridges slightly defined, leaving between them and the fissure a rather wide, smooth, convex space. Dorsal valve oval, and more or less gibbose, with a slight longitudinal depression along the middle; marginal line slightly flexuous, almost straight or gently convex in front. Surface of valves ornamented by numerous simple angular ribs, rarely exceeding two lines in width at their greatest breadth; one or two sometimes bifurcating. The dental plates of the ventral valve, converging in a trough-like shape for half the depth of the valve, then coalesce into a strong median plate, which extends two-thirds or more down the valve. In the dorsal valve two much smaller, separate, longitudinal septa, with a narrow space between them, extend to about half the length of the valve, and to which the socket-plates converge and join, as in the corresponding plates of the ventral valve. Three specimens measured—

Length 4 inches 9 lines, width 3 inches 2 lines, depth 2 inches 10 lines.

“ 2 ” 4 ” ” 2 ” 2 ” ” 1 ” 8 ”

“ 1 ” 4 ” ” 1 ” 11 ” ” 1 ” 4 ”

Obs. In his charmingly written book, ‘A Summer’s Ramble amongst the Hebrides,’ that distinguished palæontologist, Hugh Miller, remarks how preferable it is to hazard the risk of being even tediously minute in descriptions, to incurring the danger of being inadequately brief in them. But, “alas! for purposes of exact science, rarely are verbal descriptions other than inadequate.” The truth of this is by myself constantly felt; and as it is impossible to draw up a description fully answering to the shape of every specimen, the general characters must be more particularly aimed at in the written definition; and, as much as possible to make amends for my own shortcomings, I have endeavoured to speak to the eye by the means of numerous illustrations. While stating how variable are the forms assumed by this species, I may remind the student that in Pl. XVI and XVII he will find the principal modifications assumed by *P. Knightii*, and I leave to his imagination the task of connecting them by every gradation of shape. *P. Knightii* was well figured by James Sowerby in 1813; and his description,¹ although somewhat

¹ Thus Sowerby states, “The septa in the flat valve extend to its edge” (this is not correct, for they extend only half way); “they are near each other and parallel. The septum in the other valve divides the beak; the divisions extending to the edge of the shell form a kind of double beak, much resembling the horny part of the toes of a pig’s foot, and leave an angular hollow within the curve: the stone that fills this hollow commonly separates easily, and may at first sight be taken for a third valve of a triangular carinated form. The edge of the deep valve appears to extend over that of the flatter one; the length of the curve, from the apex to the edge, is often six inches. About half a mile up the River Teme, near Downton Castle, the dell is bounded by two steep rocks, approaching to each other; and the parts of the land above are level and alluvial, as if a lake had been there before the present chasm in the rock. On the southern rock (a dark-grey limestone) these extraordinary split shells are found, and are situate about twenty feet above the level of the river. I am greatly obliged to T. A. Knight, Esq., of Downton,

quaint and defective, shows that the author was acquainted with the internal characters of the shell, and regarded these of sufficient importance for the creation of the excellent genus *Pentamerus*. His *Pentamerus Aylesfordii*, however, is certainly no more than a transverse variety of the species under description. The ribs on the surface of *P. Knightii* are at times irregular in width.

The facility with which the shell separates along the middle is due to the two continuous longitudinal septa in the ventral valve, which are well exhibited in Pl. XVI, fig. 2. It is probable that the space left free between the V-shaped plates, or central chamber, was occupied by the digestive organs, while the large lateral spaces were filled up by the ovaries and the spiral arms.

Of *Pentamerus Knightii* the largest example I have seen (found by Dr. Lloyd at Mocktree, near Ludlow, and now in the Ludlow Museum) is represented in Pl. XVI. *P. Knightii* is exceedingly common in certain localities, and all our museums possess many excellent examples. In the Swedish island of Färö, in the Baltic, the species does not appear to exist, but is replaced by an allied and equally large form, named *P. tenuistriatus*, by Walmstedt.¹

Position and Locality. *P. Knightii* occurs rarely in the Wenlock and Upper Ludlow formations; but it is exceedingly common in the Aymestry limestone at Mocktree, near Ludlow, where I have picked it up on several occasions; at Aymestry, in Herefordshire, and at Leintwardine, Shropshire. It occurs near Sedgley, near Wolverhampton; and Prof. Phillips obtained it at Ridge Hill Farm, in the Abberley district, and at Bodenham, in the Woolhope district: all in Aymestry limestone. In the Museum of the Geological Survey in London there are some specimens from the Wenlock limestone of Walsall and Wenlock Edge. In Ireland it occurs east of Ferriter's Cove, Dingle, Co. Kerry; but no specimen has yet been discovered in the Upper Silurian rocks of Scotland. On the Continent, it has been found in Russia, Bohemia, &c.

for the first specimen of this shell in 1809. I have since received specimens from A. Carlisle, Esq., which have much assisted in illustrating its curious structure, collected by him when on a visit to the gentleman mentioned. A. Aikin, Esq., had observed this formation, and the discovery of the under shells, and mentioned them to me at the meeting of the Geological Society in February, 1812."

¹ *Pentamerus Volgicus*, De Verneuil, is another large species, very nearly allied to *P. Knightii*, found in various localities in the Ural Mountains. At p. 115 of the great work on the 'Geology of Russia and the Ural Mountains,' De Verneuil details the differences observable between his species and our own *P. Knightii*; but I have not yet been able to detect them, as clearly as my friend De Verneuil, in a specimen of the species sent me by Prof. F. Schmidt. The ribs in the Russian specimens of *P. Knightii* figured by M. V. Gruenewalt are much finer than on any of our British examples.

PENTAMERUS GALEATUS, *Dalman* (sp.). Pl. XV, figs. 13—23.

- ATRYPA GALEATA, *Dalman*. Kongl. Vetens. Acad. Handlingar., p. 130, 1827.
 TEREBRATULA GALEATA, *Von Buch*. Ueber Terebrat., 1834.
 TRIGONOTRETA CASSIDEA, *Bronn*. Lethæa Geog., vol. i, p. 78, pl. ii, fig. 9, z, 1835
 (non *T. cassidea*, Dal.).
 ATRYPA GALEATA, *Hising*. Lethæa Suecica, p. 76, pl. xii, fig. 1, 1837.
 — — *J. de C. Sow*. Sil. Syst., pl. xii, fig. 4, 1839.
 PENTAMERUS GALEATUS, *Conrad*. Geol. Rep. New York, 1840.
 TEREBRATULA GALEATA, *De Castelnau*. Terrain Sil. de l'Amérique du Nord, p. 39,
 pl. xiv, fig. 4, 1843.
 PENTAMERUS GALEATUS, *Murch.*, *Fern.*, and *Keys*. Geol. Russia, vol. ii, p. 120, pl. viii,
 fig. 3, 1845.
 — — *De Keyserling*. Wiss. Beobacht. Reise in das Petschora-land,
 p. 236, 1843.
 TEREBRATULA GALEATA, *Roemer*. Verst. Harzgeb., p. 19, pl. xii, fig. 25, 1843.
 — ? TUMIDA, *Eichwald*. Leth., 202; Bull. Moscou, vol. xix, p. 110, 1846.
 PENTAMERUS GALEATUS, *De Verneuil*. Bull. Soc. Géol. France, 2nd ser., vol. iv,
 p. 690, 1847.
 — — *Barrande*. Naturw. Abhandl., vol. i, p. 465, pl. xvi, fig. 5,
 1847.
 — — *Bronn*. Index Pal., p. 944, 1848.
 — — *Dav.* Bull. Soc. Géol. de France, 2nd ser., vol. v, p. 333, 1848.
 — — *Phillips and Salter*. Mem. Geol. Survey, vol. ii, part i,
 p. 291, 1848.
 — — *D'Orb.* Prodrôme, vol. i, p. 41, 1848.
 — — *Quenstedt*. Handb. Petrefactenk., pl. xxxvi, fig. 39, 1851.
 — — *M'Coy*. Brit. Pal. Foss., p. 208, 1852.
 — — *Schnur*. Eifel Brachiopod., in W. Dunker und H. v. Meyer's
 Palæontographica, vol. iii, p. 196, pl. xxix, figs. 2, a—b,
 1853.
 — — *C. Giebel*. Silur. Fauna Unterharzes, 1853.
 — — *Morris*. Catal. Brit. Foss., p. 142, 1854.
 — — *Gruenewaldt*. Mém. Sav. Étrang., vol. vii, p. 28, pl. v, fig.
 18, a—c, 1854.
 — — *Bigsby*. Quart. Journ. Geol. Soc., vol. xiv, p. 410, 1858.
 — — *Salter*. Siluria, 2nd edit., pl. xxi, figs. 8, 9, 1859.
 — — *Helmersen*. Geol. Bemerk. Reise in Schweden und Nor-
 wegen; Mém. Acad. Sc. St.-Petersbourg, 2nd ser., p. 309,
 1858.
 — — *D'Eichwald*. Lethæa Rossica, Période Ancienne, vol. i, pl.
 xxxv, figs. 19, 20, 1859.
 — — *Hall*. Pal. New York, vol. iii, p. 257, pl. xlvii, fig. 1 a—z;
 pl. xlvii, fig. 1 a—m, 1859.
 — — *Lindström*. Proc. Royal Acad. Stockholm, p. 365, 1860.
 — — *Salter*. Explan. Sheets 168, &c., Geol. Surv. Ireland, p. 13,
 1863.

Spec. Char. Shell varying much in shape, longitudinally (obscurely) ovate or sub-pentagonal, not uncommonly about as wide as long, or transversely elliptical; sometimes almost circular, very convex, almost globose. Ventral valve gibbose, greatly arched, much deeper than the opposite valve, with a broad, slightly elevated mesial fold, commencing at about the middle of the shell, and extending to the front, but sometimes entirely absent, the valve being then uniformly convex; beak large, ventricose, and usually so much incurved as to overlie, and even come into contact with, the umbone of the dorsal valve, so that the triangular fissure beneath the beak is but rarely exposed; the lateral portions of the beak slope gradually, by a convex curve, to the edge of the fissure. Dorsal valve often almost circular; posteriorly, evenly convex and gibbous until it reaches about the middle of the valve, when a broad and more or less deepened sinus commences, which extends to the front; lateral margins flexuous, front depressed into a concave wave. Surface of quite young shells sometimes smooth, and marked only by concentric lines of growth; but generally one, two, three, or more obtusely angular ribs commence at about the middle of the valves, and extend along the fold and sinus, the lateral portions remaining smooth. In other specimens, on each of the lateral portions of the valve two or more ribs exist in the vicinity of the margin, and are often of unequal size and width; while as many as from nine to fifteen are sometimes present on each valve, some of these being occasionally partly divided along the middle or bifurcated. Shell impunctate. In the interior of the ventral valve the dental plates converge, and form a curved, trough-like process, or long, spoon-shaped chamber, while the vertical median septum extends to about one third of the length of the valve, and in its upper part becomes united to the conjoined dental lamellæ. In the interior of the dorsal valve two much longer longitudinal septa, with a small free space between them, extend about two thirds the length of the valve; and to these the lengthened socket-walls or plates converge, and, when joined, form two more or less developed plates, inclined outwards, corresponding with the trough-like plates of the ventral valve. Three specimens measured—

Length 19, breadth 18, depth 16 lines.

„ 13, „ 13, „ 9 „

„ 14, „ 12, „ 10 „

Obs. This very variable and exceedingly far-spread species has been much more fortunate than many of its congeners; for, although it has been once or twice placed in the genera *Terebratula*, *Trigonotreta*, and *Atrypa*, almost every author has retained for it the designation *galeatus*, given to it by Dalman in 1827; for I believe that M. Gruenewalt can scarcely be correct while identifying the *Pentamerus Wurmii* of F. A. Römer with the *Atrypa galeata* of Dalman; and although identified as the *Atrypa cassidea* of Dalman by Bronn in 1835, the mistake was subsequently corrected by Bronn himself at p. 1288 of his 'Lethæa Geognostica.' *Pentamerus galeatus* is easily distinguished from *P. Knightii* both by its external shape, and especially by internal differences, the median septum being shorter and conjoined, supporting but half the V-shaped chamber; and

a glance at their respective figures will easily explain this. It appears to be more variable in shape than *P. Knightii*. The specimen upon which Dalman founded his species had twelve to fifteen ribs on each valve, and the fold and sinus developed. In some specimens the valves are almost equally and uniformly convex, without fold or sinus; and while other examples are either smooth or have ribs obscurely marked, some specimens are strongly ribbed. All these variations have been drawn in our plate, and have been selected from several hundred examples.

Position and Locality. The vertical range and geographical distribution of *Pentamerus galeatus* is very considerable; for it is common to the Wenlock, Middle Ludlow, and Devonian formations. It abounds in the Wenlock limestone and Upper Wenlock shales near Walsall and Dudley.¹

Messrs. Phillips and Salter enumerate the following localities:—In Wenlock limestone and shale at Storrige, Ledbury, Eastnor Park and Castle, Dunbridge Wood, east of Ledbury, Brock Hill section, in the Malvern district; at Hill End, and Callow Farm, Abberley district; east of Canwood, Checkley Common, Dormington Wood, Lindels, &c., in the Woolhope district; the Rock, May Hill district; Swansea Road and Golden Grove, Llandeilo district. In the Lower Ludlow, at Brock Hill section, Malvern district, and Hill End, Abberley district; in the Aymestry limestone, west of Rilbury, Malvern district; Llanbadoc, Beech Hill, Ty-Newydd, Usk district.

In Ireland, it occurs, with *P. Knightii*, in the Croaghmarhin (Aymestry) beds, Ferriter's Cove, Co. Kerry (Salter), and at Cahirconzee, west side (Mus. Geol. Survey, Ireland). It has not been hitherto positively detected in Scotland; but some casts found in the Llandovery rocks, in the Girvan district, Ayrshire, bear much resemblance to those of the species under description.

Abroad, it has been found in many countries and localities. In the Island of Gothland, it occurs in the "Middle Gothland" of Lindström, and thence Dalman's type was

¹ Mr. Allport has expressed a just regret that it is not a more common practice for collectors to be particularly careful in affixing the exact localities to their specimens; as, by making use of the term "Dudley," very much confusion has already arisen as to the Silurian fossils obtained from that district. He remarks that, with regard to deductions made by comparing the fossils from the Dudley shale, supposed to represent the Lower Ludlow formation, he does not attach much weight to such comparison, as the rocks near Ludlow are of an arenaceous character, indicating that they were deposited under very different circumstances from the mud beds found near Dudley. Mr. C. Ketley, in an interesting paper in vol. ii, p. 105 (Dec., 1865) of the 'Transactions of the Dudley and Midland Geological and Scientific Society,' seems to consider that, on the whole, the fauna of the upper shale, overlying the Dudley limestone at East Wren's Nest, Parke's Hall, &c., and which is so well known for the variety and beauty of its fossils, has a closer relationship to the limestone below it than to that of the rocks above. He adds, "Of Brachiopoda the upper shale has twenty-nine species, twenty-four of which are also found in the limestone below. The Lower Ludlow of Ludlow has ten species, of which six are common to the limestone and upper shale also, and two of them to the upper shale." As it must be confusing to some who have not access to the locality, but seek information as to its rocks and fossils, to find this shale named "Lower Ludlow" by one authority and "Wenlock Shale" by another, Mr.

obtained. M. de Verneuil describes it from black Devonian (?) limestone at Ustkataf, between Jurjusensk and Simsk, in the south of the Ural Mountains, and from Bogoslofsk, in the South Urals. M. Barrande found it in the Upper Silurian rocks of Bohemia; and Prof. Hall states, at p. 259 of vol. iii of his 'Palæontology of New York,' that "this

Ketley has drawn up the following Table as a guide, which, although not quite complete, is here reproduced, as it illustrates a subject upon which further careful observations should be made:

BRACHIOPODA.	Wenlock Limestone, Dudley.	Upper Shale, Dudley.	Lower Ludlow of the Ludlow District.
<i>Athyris tumida</i>	39	39	39
<i>Atrypa reticularis</i>	39	39	—
<i>Retzia cuneata</i>	39	39	—
<i>Spirifer crispus</i>	39	39	—
— <i>plicatellus</i>	39	39	39
— — <i>var. interlineatus</i>	—	39	39
— <i>trapezoidalis</i>	39	39	—
<i>Pentamerus galeatus</i>	39	39	39
<i>Rhynchonella deflexa</i>	39	39	—
— <i>Lewisii</i>	39	39	—
— <i>nucula</i>	39	39	—
— <i>Wilsoni</i>	39	39	—
<i>Leptaena transversalis</i>	39	39	—
<i>Orthis biloba</i>	39	39	—
— <i>elegantula</i>	39	39	39
— — <i>var. obicularis</i>	39	39	—
— <i>hybrida</i>	39	39	—
<i>Strophomena depressa</i>	39	39	39
— <i>euglypha</i>	39	39	—
— <i>filosa</i>	39	39	—
— <i>funiculata</i>	39	39	39
<i>Chonetes lævigata</i>	—	—	39
— <i>minima</i>	39	39	—
<i>Discina Forbesii</i>	39	39	—
— <i>striata</i>	39	39	—
— <i>rugata</i>	39	39	—
<i>Lingula Symondsii</i>	—	39	39
— <i>lata</i>	—	—	39
— <i>Lewisii</i>	—	39	—
<i>Obolus Davidsoni</i>	39	39	—
— <i>transversus</i>	39	39	—

At p. 430 of vol. iii of the 'Geological Magazine' (Sept., 1866), Dr. Holl observes that the above-mentioned Upper Wenlock Shales, notwithstanding the Wenlock aspect of their fauna, are considered, on good authority, to belong to the base of the Ludlow series. Mr. Salter refers the student to Sir R. Murchison's often repeated statement, that the Lower Ludlow seems but to be an Upper Wenlock Shale; where the former is represented by mud-stone the fossils are like those of the Wenlock. The Brachiopods have a greater range than the other shells.

species is characteristic of the Lower Pentamerus-limestone (Lower Ludlow rock) of the Lower Helderberg group; and large masses of the rock are often made up of the broken and separated valves of this fossil. The more perfect specimens are obtained from the shaly limestone above the Pentamerus-limestone, Helderberg Mountains, Schoharie, Carlisle, Cherryvally; Herkimer Co., Catskill, Hudson, and numerous other places in New York State; Cumberland, in Maryland, Decatur Co., in Tennessee, and at numerous other points." Prof. Schnur describes and figures Devonian specimens from the Eifel, which exactly resemble those from our Silurian deposits.

PENTAMERUS LINGUIFER, *J. de C. Sow.* (sp.). Pl. XVII, figs. 11—14.

ATRYPA LINGUIFERA, *J. de C. Sow.* Sil. Syst., pl. xiii, fig. 8, 1839.

PENTAMERUS LINGUIFER, *Davidson and De Verneuil.* Bull. Soc. Géol. France, 2nd ser., vol. v, pp. 333 and 346, 1848.

— — *Phillips and Salter.* Mem. Geol. Surv., vol. ii, part 1, p. 277, 1848.

— BUBO, *Barrande.* Sil. Brach. Böhmen. Naturw. Abhandl., vol. ii, p. 116, 1847.

— LINGUIFER, *D'Orb.* Prodrome, vol. i, p. 41, 1849.

— — *Morris.* Cat. Brit. Foss., p. 142, 1854.

— — *F. Schmidt.* Sil. Form. Ehstland, &c.; Archiv Naturk., &c., vol. ii, p. 212, 1858.

— — *Salter.* Siluria, 2nd edit., pl. xxii, fig. 21, 1859.

— ROTUNDUS, *Lindström.* Proc. Royal Acad. Stockholm, p. 365, pl. xii, fig. 6, 1860.

Spec. Char. Sub-globose or orbicular, slightly wider than long, very rarely longer than wide; ventral valve gibbous, becoming very ventricose in old specimens, and especially near the beak, and divided longitudinally along the middle by a narrow groove, as well as by a broad shallow sinus; beak moderately large and somewhat compressed along the middle, greatly incurved, so as almost to come into contact with the umbone of the dorsal valve, the small triangular fissure beneath being rarely exposed. Dorsal valve somewhat transversely oval, and divided into three portions by a moderately elevated mesial fold; front raised into rounded waves; surface smooth, marked only by a few concentric lines of growth. In the interior of the ventral valve, the dental lamellæ are developed into a small V-shaped cavity or chamber, extending freely into the cavity of the shell, and supported by a small vertical septum only at its posterior extremity. Inside the dorsal valve two very narrow septa, with a small intervening space, support two small plates, curving outward, and corresponding with those of the opposite valve. Two specimens measured—

Length 9, width 10 depth $7\frac{1}{2}$ lines.

„ 10, „ 9, „ $7\frac{1}{2}$ „

Obs. *Pentamerus linguifer* is a much smaller and more stumpy-looking species than *P. galeatus*, and is at once distinguished from it by having its mesial fold on the dorsal valve, whilst in Dalman's species it occurs on the ventral valve; and the same applies to the sinus. It is also smooth, and the fold is often somewhat bent upwards towards its exterior, as seen in fig. 15 *b* of our plate; but this is not always the case, as fig. 11 *a* exemplifies. Its interior is also well distinguished from that of *P. galeatus* by the still smaller development of the conjoined dental lamellæ, or the V-shaped chamber in the ventral valve, as well as in the smallness of the vertical septum which supports it. Dr. Lindström allows me to state that he considers his *P. rotundus* to be a variety or a small individual of the shell under description. *Pentamerus (Spirifera?) Bubo*, Barrande, though a somewhat larger shell, did appear to M. de Verneuil and myself, in 1847, to be the same as our *P. linguifer*. When quite young, the fold and sinus are scarcely apparent.

Position and Locality. *Pentamerus linguifer* appears not to be restricted to the Woolhope and Wenlock limestones and the Wenlock shales; Mr. Salter says it is plentiful in the Upper Llandovery conglomerates west of the Malvern Hills. Dr. Holl found it in the Woolhope limestone, and in the shale immediately above it, at Malvern, at the Pound and Crews Hill, both near Alfric, and four miles to the north of Malvern. I have picked it up at the Rushall Canal near Walsall, at Dudley, and along the Benthall Edge near Wenlock. The Geological Surveyors have obtained it from Presteign and May Hill, as well as from other localities. Sir Roderick Murchison found it at Stumps Wood, Valley of Woolhope, and Delves Green, in Wenlock shale. It has not, to my knowledge, been found either in Scotland or Ireland, and Mr. Salter agrees with me.

Abroad, it was discovered, for the first time, in the Upper Silurian beds of Gothland by Lindström, and in Russia by Schmidt.

PENTAMERUS ROTUNDUS, *J. de C. Sow.* (sp.). Pl. XV, figs. 9—12.

ATRYPA ROTUNDA, *J. de C. Sow.* Sil. Syst., pl. xiii, fig. 7, 1839.

— — *Phillips and Salter.* Mem. Geol. Survey, vol. ii, part 1, p. 279, 1848.

HEMITHYRIS ROTUNDA, *M'Coy.* Brit. Pal. Foss., p. 205, 1852.

RHYNCHONELLA — *Morris.* Cat. Brit. Foss., p. 147, 1854.

— — *Salter.* Silur., 2nd edit., pl. xxii, fig. 18, 1859.

Spec. Char. Orbicular, or a little wider than long; sides and front rounded; ventral valve smooth and moderately convex to within two thirds of the length of the valve, where a broad sinus commences and extends to the front; two or three rounded ribs occupy the sinus, while the lateral portions of the valve are either smooth, or ornamented by two or three ribs on each side, but these do not extend further than to a very short distance from the margin; beaks small, and but little produced beyond the

umbone of the opposite valve. Dorsal valve rather more convex than the ventral, with a broad fold, which, commencing at the front margin, extends to a short distance only, and dies out. In some specimens three or four rounded ribs occupy the fold, the lateral portions of the valve remaining smooth; while, again, in other examples, two or three ribs exist also close to the margin, as seen in the ventral valve. Inside the ventral valve, a short septum supports a small V-shaped chamber, formed by the converging dental plates. Two specimens measured—

Length 7, width $7\frac{1}{2}$, depth 5 lines.

„ 10, „ 10, „ 6 „

Obs. It is with considerable hesitation that I place this species in the genus *Pentamerus*, as I am imperfectly acquainted with its internal characters; but Mr. Salter tells me it has a good septum and V-shaped chamber. The lines observable on the surface of some specimens, and an internal cast in the collection of Sir R. Griffith, described in the 'Synopsis of Irish Sil. Fossils' by McCoy as *Atrypa rotundata* (fig. 12 of my plate), lead me to believe it is a true *Pentamerus*. This fossil appears to vary to some extent in the presence or absence of ribs on the lateral portions of the valves. The beaks are also very approximate.

Position and Locality. Murchison's original example, which can be seen in the Museum of the Geological Society, was found in the *Wenlock limestone* of Wenlock Edge. It occurs also in the *Woolhope limestone* of the Malvern district less rarely. Prof. McCoy mentions it from sandstone at Alt Goch, Llanfyllin, Montgomeryshire (but no such specimen is in the Cambridge Museum; and it is probably a mistake). The Irish specimen described by McCoy is from Kilbride, Cong, Co. Galway, in May Hill sandstone, or *Upper Llandovery* rock.

PENTAMERUS OBLONGUS, J. de C. Sow. Pl. XVIII, figs. 1—12; Pl. XIX, figs. 1, 2.

- PENTAMERUS LEVIS, Sow. Min. Con., vol. i, p. 76, pl. xxviii, June or August, 1813.
- OBLONGUS, J. de C. Sow. Sil. Syst., pl. xix, fig. 10 (not fig. 12), 1839.
 - LEVIS, Sow. Sil. Syst., pl. xix, fig. 9, 1839.
 - OBLONGUS, Hall. Geol. Report New York, p. 7, figs. 1—5, 1843.
 - — McCoy. Synop. Sil. Foss. Ireland, p. 38, 1846.
 - — De Vern. Bull. Soc. Géol. France, 2nd ser., vol. iv, p. 690, 1847.
 - LEVIS, Phillips and Salter. Mem. Geol. Surv., vol. ii, part 1, p. 292, 1848.
 - OBLONGUS, Bronn. Index Pal., p. 945, 1848.
 - — et LEVIS, D'Orb. Prodrome, vol. i, p. 20, 1849.
 - — Salter. Journ. Geol. Soc., vol. vii, pp. 171, 172, 1851.
 - — Hall. Pal. New York, vol. ii, p. 79, pl. xxv, fig. 1, and pl. xxvi, fig. 1, 1852.

- PENTAMERUS OBLONGUS, *McCoy*. Brit. Pal. Foss., p. 211, 1852.
 — LEVIS, *Id.* Ibid., p. 209, 1852.
 — — (P. OBLONGUS, *Sow.*), *Morris*. Catal. Brit. Foss., p. 142, 1854.
 — OBLONGUS, *Bigsby*. Quart. Journ. Geol. Soc., vol. xiv, p. 410, 1858.
 — — *Salter*. Siluria, pp. 100 and 230, fig. 2, and pl. viii, figs. 1, 2, 3, 1859.
 — — *Eichwald*. Lethæa Rossica, vol. i, p. 788, 1859.
 — ESTHONUS, *Lindström*. Proc. Roy. Akad. Stockholm, p. 365, 1860.
 — LEVIS (young of P. OBLONGUS), *Salter*. Mem. Geol. Survey, vol. iii, pp. 276 and 360, 1866.

Spec. Char. Longitudinally oval or ovate, sub-trigonal; valves moderately and almost equally convex, in some cases depressed; young shells evenly convex and smooth, older shells usually much trilobed. Mesial fold in dorsal valve tolerably broad, of small elevation, slightly depressed along the middle, while that on the ventral valve is rounded; beak moderately produced, and so much incurved as to touch the umbone of the dorsal valve; fissure under the beak triangular, not much exposed; beak-ridges sharply defined, and leaving between them and the hinge-line a concave space (not a true area). Surface of valves smooth, with sometimes a few irregular furrows and concentric lines of growth. Inside the ventral valve a long vertical median septum, extending to two thirds or more of the length of the valve, supports the conjoined trough-shaped dental plates. In the dorsal valve two similar long, vertical septa, with a small free space between them, support two outwardly sloping plates, which correspond with the trough-shaped plates or V-shaped cavity of the opposite valve. Shell-structure impunctate. Two specimens measured—

Length 2 inches 3 lines, width 2 inches 3 lines, depth 1 inch 5 lines.

” 8 ” 8 ” (*P. levis*, *Sow.*)

Obs. Prof. J. Hall, at p. 79, vol. ii, of his ‘Palæontology of New York,’ says, “It is impossible to give a description which shall be applicable to every form of a shell so variable as this species. In the smaller and medium-sized forms, in the Pentamerus-limestone of the Clinton group at Rochester and elsewhere, the shell has a general oval or ovate form, sometimes slightly trilobate at base; it is so much depressed that the thickness or depth of both valves is only about half the width. This proportion sometimes continues even in very old shells, the trilobate character of the base being often very conspicuous. In the majority of specimens, however, the valves become gradually more gibbous as the shells increase in size, and the trilobate character may be either preserved or entirely lost. In young shells usually the surface is marked only by concentric striae, though in some instances distinct lines of growth give a more uneven surface, and this character becomes more prominent with increasing age. Although the general and prevailing form is oval or ovate, yet we not infrequently meet with forms that are rounded, and the ventral valve wider than long.” What Prof. Hall has observed with reference to the variations assumed by this shell in America will be found equally applicable to those that occur in Great Britain and in Europe; but none of the specimens

appear to be as large as some of those from Sweden and the Baltic provinces, if we are to consider Eichwald's *Pentamerus Esthonus* ('Bull. Soc. Imp. Nat. Moscou,' part i, p. 91, 1854, and 'Lethæa Rossica, Période Ancienne,' vol. i, pl. xxxiv, fig. 23, 1859) as a synonym of the shell under description. I have myself seen specimens of the shell so named, sent to me by Prof. F. Schmidt, of St. Petersburg, and others given to me by Dr. Lindström from the Middle Gothland series of Carlsö, Klinteberg, and Bogeclint, without having been able to detect any difference, except the larger dimensions. Both Schmidt (p. 213 of 'Untersuch.') and Lindström consider it questionable whether this shell is different from *P. oblongus*. At p. 789 of his 'Lethæa Rossica,' d'Eichwald enters into long details in the endeavour to establish his view, that *P. oblongus* and *P. Esthonus* are distinct species; but the subject will require further examination. The British, Swedish, and Russian specimens of *P. oblongus*, as well as the generality of the American examples, have their valves moderately convex; but some very fine casts from Springfield and Dayton, Ohio, figured by Prof. Hall in pl. xxvi of vol. ii of his 'Pal. New York,' are exceedingly gibbous, measuring $4\frac{1}{2}$ inches in length, 3 inches 3 lines in width, by about the same in depth; and the dimensions would be somewhat larger were the shell preserved. *P. Esthonus* also attained those dimensions both in length and width, but with a much lesser depth.

It is admitted now by most palæontologists that *P. lavis*, Sow., is the young of *P. oblongus*; and if it were necessary to strictly adhere to the rules of priority, James Sowerby's name, published in August, 1813, would perhaps require to be adopted in preference to that of *oblongus*, given to the adult shell by Mr. J. de C. Sowerby in 1839; but when we read over Mr. James Sowerby's unsatisfactory description,¹ and look at his small, very incomplete figure, we think it preferable to preserve for the shell the now generally adopted and well-known designation of *oblongus*. In 1839 Mr. J. de C. Sowerby described, it is true, in the 'Silurian System,' *P. lavis* and *P. oblongus* as distinct species; but, judging from the single figured fragment of a ventral valve of *P. lavis*,

¹ "*Pentamerus lavis*, J. Sowerby, 'Min. Conch.,' vol. i, p. 76*, tab. xxviii, fig. 2 (right-hand figure). August, 1813. [In our Pl. XIX, fig. 2, this illustration is reproduced.]

"*Spec. Char.* Smooth, triangular, front rounding, beaks incurved. Much less gibbous than either of the last (*P. Knightii* and *P. Aylesfordii*), free from furrows, but having slight depressions over the septa; length generally less than an inch. Not having found this in a perfect state, although I have had stones including hundreds of specimens, I have been doubtful whether I ought to admit it. The Rev. D. Abbot, of Bedford, in May, 1812, was so kind as to bring me pieces of rolled limestone with three small dividing shells, from near Hopton Court, where he thought they appeared to be left by the swell of the River Teme, and formed a bank three feet or more high. Sometimes, I think, there are two species in the stone, a smooth and a furrowed one [doubtless *P. liratus*], but better chance than I have had must determine this; at the same time, one formation is distinctly characterised. The same stones contain the remains of Madreporæ. The specimen figured is from Buildwas, Shropshire, collected by A. Aikin, Esq. In some specimens I perceive the remains of small *Entrochi*." Near Buildwas, Shropshire, the Wenlock limestone, and also the Pentamerus or May Hill sandstone, are well developed. (J. W. S.)

he could not have had an opportunity of comparing a perfect example of it with the complete specimens of *P. oblongus* figured by him in the same plate.

Position and Locality. *Pentamerus oblongus* would appear to be restricted to the Lower and Upper Llandovery rocks, and to be very much more abundant in the last-named formation. At page 229 of 'Siluria,' (2nd ed., 1859), it is stated that, "In the Lower Llandovery rocks of South Wales *P. undatus* and *P. lens* are everywhere found, *P. globosus* and *P. oblongus* being rare. In the upper series, whether in South Wales, Shropshire, or in the South of Scotland (as at Saugh Hill, near Girvan), *P. oblongus* is the prevailing fossil, occurring often in great banks, to the exclusion of all other fossils, but generally accompanied by the species just named. At May Hill and the Malverns *P. lens* is by far the more common species; *P. liratus* accompanies both these in the higher beds, and is the only one of the five species which ranges into the base of the Wenlock formation." Among the English and Welsh Lower Llandovery localities may be named Cyn-y-brain, Wrexham, Denbighshire; Cefn, three miles north-east of Welshpool, near Buttington; also near Builth, and at Noedd-Grug and Llandovery, rare (J. W. S.). In the Upper Llandovery, Nash Scar (Prestegn); Norbury, Bishops Castle, Stone Acton, Church Stretton, Chirbury, Hope Bowlder, and the Hollies, in Shropshire;¹ Pen Cerrig, Builth; Llangadoc; Wooltack Park, Pembrokeshire; Rose Market, near Haverfordwest, and Johnston; Pen-y-lan; Old Storridge, near Malvern.

Prof. M'Coy mentions Pwllheli, Carnarvonshire, and some other localities, giving the "Upper Bala sandstone" and "Caradoc sandstone and limestone," such as that of Soudley and Horderley, Shropshire: in all these the May Hill sandstone is meant (J. W. S.).

At p. 292 of the 2nd vol., part 1, of the 'Memoirs of the Geol. Survey of Great Britain,' Messrs. Phillips and Salter mention Fair Oaks, Gunwick Mill, and Howler's Heath, *Malvern district*; Ankerdine Hill, *Abberley district*; May Hill, and Huntley, *May Hill district*; Mandinam, *Llandeilo district*.

In Scotland, it abounds in the Yellow Llandovery Sandstone of Saugh Hill and Penwhapple Glen, the conglomerates of Cuddystone Glen, and the blue limestone of Ardmillan and Penkill, near Girvan, Ayrshire. These are Upper Llandovery (Salter).

In Ireland, it is stated by Prof. M'Coy, in his 'Synopsis of Silurian Fossils,' to occur in the (Llandovery) sandstone of Boocaun, Cong, Co. Galway (very abundant in one bed), and in the sandstone of Cappacorogue, Cong. A fine valve from this place will be found figured in our plate. Mr. Salter found it on the precipices west of Dingle; and it occurs in the Lower Old Red conglomerates of that wild district, washed out in Devonian times from the May Hill rocks (J. W. S.).

Abroad, *P. oblongus* is equally abundant. In Russia Prof. P. Schmidt mentions

¹ The masses of blue limestone full of the broad-arrow-like sections of the shell are the "Jacobstones" of Shropshire. The line of the formation may be traced by the door-sills and well-steps of the cottagers.

Ruhde, Keskfer, Kattentach, Nudi, Jerwakant, Kerro, Fennern, Oberphahlen, Rostla, &c. In Sweden Dr. Lindström found it at Strora, Lilla Carlsö, Klienteberg, Bogeklint. It occurs also in the Upper Llandovery (?) in the neighbourhood of Christiania in Norway. In North America in the Clinton group at Rochester and elsewhere; at Springfield and Drayton, Ohio; on the west side of the Mississippi River, &c. M. de Verneuil observes that in North America, as well as in England, *P. oblongus* occurs near the point of junction of the Upper and Lower Silurian groups, but in those beds which appear to belong more properly to the Upper Silurian; also that he found it at Richmond, Indiana, Galena (Illinois), at Seulchoix, Green Bay; also at Limekiln Island, and other islands of Lake Huron. Sir W. Logan has obtained it near the River Ottawa, and at Gaspé, in Canada. Dr. Bigsby obtained it further west and north; but it is not yet known, nor the band containing it, in the Arctic basin.

PENTAMERUS UNDATUS, *J. de C. Sow.* (sp.). Pl. XIX, figs. 4—9.

ATRYPA UNDATA, *J. de C. Sowerby.* Sil. Syst., pl. xxi, fig. 2, 1839.

— — *Phillips and Salter.* Mem. Geol. Surv., vol. ii, part 1, p. 279, 1848.

PENTAMERUS UNDATUS, *M'Coy.* Brit. Pal. Foss., p. 211, 1852.

— — *Morris.* Cat. Brit. Foss., p. 143, 1854.

— — *Salter.* Siluria, 2nd edit., pp. 100 and 230, fig. 6; pl. viii, figs. 5, 6, 7, 1859.

— — *Id.* Mem. Geol. Survey, vol. iii, pp. 276 and 360, 1866.

Spec. Char. Transversely oval; much wider than long; valves convex; ventral valve most so, even gibbous, with a wide, sharply defined sinus commencing at the extremity of the beak and extending to the front, sometimes longitudinally divided along the middle by a slight elevation; beak much incurved. Dorsal valve with a wide rounded fold of small elevation; sides rounded, and slightly indented in front. Surface smooth, marked only by concentric lines of growth. In the inside of the ventral valve the V-shaped chamber formed by the union of the converging dental plates is small, as well as the vertical septum which partly supports it. Two specimens measured—

Length 7, width 10, depth 6 lines.

„ 11, „ 16 lines.

Obs. Of this fossil I have seen many internal casts and impressions, and never the shell itself. In one of these (fig. 8ⁿ) the vascular markings are beautifully defined, while in another (partly fractured) the outer surface of the converging dental plates, as well as a small area, are exposed (fig. 8). Again, in the casts of one or two examples may be seen a short longitudinal slit due to the vertical septum. Prof. M'Coy informs us that “the internal plates are excessively small, but formed on the usual plan of

Pentamerus. I observe," he adds, "that in those species in which the plates are very small the outwardly curved marginal portion of the two diverging plates in the beak of the entering valve is unusually strong, giving to the casts the appearance of four slits in the beak, or of two slits and two oblique teeth." Mr. Salter thinks that this species, as well as *P. globosus*, may possibly belong to *Stricklandinia*.

Position and Locality. Casts of this species occur abundantly in the Lower and Upper Llandovery, but especially in the former. In the *Lower Llandovery* at Quakers' Burial Ground, and Guilsfield, Welshpool; Pen-y-Craig; Mathyrafal, south of Meifod; Llangynyw, Montgomeryshire; Noeth Grug, Cefn Rhyddan, Cefn-y-Garreg, Llandovery; Builth, Rhyader, &c.; Robeston Wathen and Haverfordwest, Pembrokeshire. In the *Upper Llandovery* at Llwyn-y-Wormwood, Mandinam, and Penlan, Llandovery; Builth, Llangadoc; Rosemarket, &c.; Malverns, Church Stretton. *Woolhope beds*, Buildwas (in 'Catalogue of Fossils, Museum of Pract. Geol.,' p. 52 (probably *P. linguifer*).

In Ireland it occurs at Ballycar, Co. Clare (Mus. Geol. Survey, Ireland).

I have not yet positively ascertained the existence of this species in Scotland, but a search for it should be made in some of the Llandovery localities in the Girvan district, Ayrshire.

PENTAMERUS GLOBOSUS, *J. de C. Sow.* (sp.). Pl. XIX, figs. 10—12.

ATREYA GLOBOSA, *J. de C. Sowerby.* Sil. Syst., pl. xxii, fig. 2b, 1839.

— — *Phillips and Salter.* Mem. Geol. Survey, vol. ii, part 1, p. 277, 1848.

PENTAMERUS GLOBOSUS, *Morris.* Cat. Brit. Foss., p. 142, 1854.

— — *Salter.* Siluria, 2nd edit., pl. viii, fig. 8, 1859.

— — *Id.* Mem. Geol. Survey, vol. iii, pp. 276 and 360, 1866.

Spec. Char. Circular, or slightly transverse-oval; globose, or, when old, sub-cuboidal, from the deflection of the front; a very shallow undefined depression in the large or ventral valve forming a shallow wave in the margin towards the opposite valve, which is evenly convex, without a corresponding ridge; lateral and frontal margins rounded. In the cast of the ventral valve a long slit, extending to nearly half the length of the valve, indicates the position of the vertical septum supporting the trough-shaped chamber or converging dental plates. The surface of the cast is also irregularly marked by obscure ridges.

Length 6, width 7 lines.

Obs. I have never been able to procure the sight of more than a few internal casts of the ventral valve of this species; consequently, I can offer only a meager and incomplete description. The form of the shell is, however, so different from that of all the other species of *Pentamerus* occurring in Great Britain, that, judging from these incomplete casts alone, it may be considered distinct.

Position and Locality. *P. globosus* is a rare fossil in either Upper or Lower Llandovery beds. In the *Lower Llandovery* it is found at Pen-y-Craig, near Meifod, North Wales, and Gorrllwyn Fach, Llandovery. In the *Upper Llandovery* at Landeilo. Messrs. Phillips and Salter mention also localities in the *Malvern district* and the *Llandeilo district*; and Wooltack Bay, in Pembrokeshire. In addition to these, Prof. M'Coy gives Beaver's Grove, Bettws-y-Coed, North Wales; but Prof. M'Coy's fossil is an *Orthis*, and from Caradoc rocks (J. W. S.).

In Ireland, at Ballyear, Co. Clare, and Kilbride (Mus. Geol. Survey, Ireland).

Since the publication of my description of the genus *Pentamerus*, at p. 95 of the "General Introduction," 'Monogr. Brit. Brachiop.,' vol. i, Mr. Billings has proposed to detach from it certain species, such as *Pentamerus liratus* and *P. lens*, which he considers to present differences of sufficient importance for the establishment of a separate genus or sub-genus, for which he has proposed the designation STRICKLANDINIA. The excellent genus *Pentamerus*, which was established by J. Sowerby as far back as 1813, was typified by the well-known *P. Knightii*, characterised as "an equal-sided, inequivalved bivalve, with one valve divided by a longitudinal internal septum into two parts, the other by two septa into three parts or valves; beaks incurved, imperforate."

We will now reproduce Mr. Billings' description of his genus, as well as the reasons why he considers it distinct from *Pentamerus*.

Genus—STRICKLANDINIA, *Billings*. *Stricklandia*, 'Canadian Naturalist and Geologist,' vol. iv, p. 132, April, 1859;¹ altered to *Stricklandinia*, 'Can. Nat. Geol.,' vol. viii, p. 370.

"*Gen. Char.* Shell usually large, elongate-oval, transversely oval, or circular, sometimes compressed; valves nearly equal; a short mesial septum in the interior of the ventral valve, supporting a small triangular chamber beneath the beak, as in *Pentamerus*; in the dorsal valve no longitudinal septa, spires, nor loop, yet observed; the whole of the internal solid organs (so far as is yet known) consisting of two very short or rudimentary socket-plates, which support prolonged calcified processes for the support of the cirrated arms. In all the species known the ventral valve has an area more or less developed. The valves articulate by teeth and sockets.

"This group of shells (*Stricklandia*), although closely related to *Pentamerus*, differs from that genus in the following particulars:—1st. In *Pentamerus* the form is globular,

¹ Mr. Billings states, in the "Appendix" to vol. i of 'The Palæozoic Fossils of Canada,' that, as the generic name *Stricklandia* is preoccupied, he has changed it to *Stricklandinia*. He also informs me that the only species of *Rensselaeria* (Hall) claimed by him as a *Stricklandinia* is Vanuxem's *Pentamerus elongatus*.

and the ventral valve much the largest. In *Stricklandia* the valves are nearly equal in size, and the form oval or heart-shaped, never globose. 2nd. In *Pentamerus* the dorsal valve has two, and sometimes three, well-developed longitudinal septa, which in most of the species sustain a small triangular chamber, as in the ventral valve. In *Stricklandia* these septa are not developed, and the triangular chamber is entirely absent. It might be thought that the difference between the short or rudimentary socket-plates of *Stricklandia* and the elongated mesial septa of *Pentamerus* should not be regarded as of sufficient importance to constitute a generic distinction, because it is only a difference in the extent to which identical parts are developed, the socket-plates of the former genus being a rudimentary state of the latter. When, however, we examine any group of closely allied genera, we find that all the grounds for separation consist in the various modifications of the same set of organs. The difference in the degree of the development of an organ is not always a good character; but when it is carried to such an extent that the whole form of the animal is affected in a particular manner, manifested in a number of species, then it becomes of generic value. If we take the several species of *Stricklandia*, and compare them with the ordinary forms of *Pentamerus*—such, for instance, as *P. Knightii*, *P. galeatus*, *P. Sieberi*, *P. acutolobatus*, *P. caducus*, &c.—the difference in the external form of the two groups is so remarkable that we should almost be warranted in separating them into two genera upon this ground alone; but when to the dissimilarity in the general form we add the difference in the internal structure, then there can be little doubt as to the correctness of the separation.”

In the first volume of ‘Palæozoic Fossils,’ published by the Geological Survey of Canada, p. 84 (1865), Mr. Billings further remarks—“This genus was proposed by me to include such shells as those known in England under the names of *Pentamerus lens*, *P. liratus*, and *P. levis*. They differ from *Pentamerus* in having the valves usually subequal, and no longitudinal septa or triangular chamber in the interior of the dorsal valve. Both valves have an area, but in the dorsal it is usually linear, or only slightly exceeding the thickness of the substance of the shell in height. The ventral valve has usually a concave mesial sinus more or less developed, and the dorsal valve a mesial fold corresponding thereto. The hinge-line in some of the species, such as in *S. levis* and *S. microcamerus*, have the hinge-line straight and much extended.”¹

¹ Mr. Billings is in error in including *Pentamerus levis* in *Stricklandia*, that shell being the young of *Pentamerus oblongus*.

STRICKLANDINIA LIRATA, *J. de C. Sow.* (sp.). Pl. XX, figs. 1—13.

- SPIRIFER LIRATUS, *J. de C. Sowerby.* Sil. Syst., pl. xxii, fig. 6, 1839.
 CARDIUM MULTISULCATUM, *Hisinger.* Lethæa Suecica, Supplementi secundi continuatio,
 p. 4, pl. xli, fig. 3, *a, b*, 1842.
 SPIRIFER OVATUS, *M'Coy.* Sil. Foss. Ireland, p. 37, pl. iii, fig. 24, 1846.
 — MULTISULCATUS, *De Verneuil.* Bull. Soc. Géol. France, 2nd ser., vol. v,
 p. 347, 1848.
 ORTHIS LIRATA, *Phillips and Salter.* Mem. Geol. Surv., vol. ii, part 1, p. 291, 1848.
 PENTAMERUS LIRATUS (SPIRIFER OVATUS, *M'Coy*), *Salter*, in Morris's Cat. Brit. Foss.,
 p. 142, 1854.
 — — *Salter.* Siluria, 2nd edit., pp. 100 and 230, fig. 3, 1859.
 — — *Id.* Mem. Geol. Surv., vol. iii, p. 360, 1860.
 CERTINA? MULTISULCATA, *Lindström.* Pro. Roy. Acad. Stockholm, p. 360, 1860.
 STRICKLANDIA LIRATA, *Billings.* Canad. Nat. and Geol., vol. iv, p. 434, April, 1859;
 Canad. Palæozoic Foss., vol. i, p. 84; *Stricklandia*, Ap-
 pendix, p. 419, 1865.
 STRICKLANDINIA — *Id.* Catal. Sil. Foss. Anticosti; Report Geol. Surv. Canada,
 p. 45, 1866.

Spec. Char. Generally transversely oval, sometimes longer than wide and ovate, or as wide as long; hinge-line nearly straight and shorter than the width of the shell; cardinal extremities angular; sides and front rounded. Valves almost equally and moderately convex, never gibbous. Dorsal valve more or less semicircular and trilobed, from the presence of a rather wide mesial fold of small elevation, which, commencing at the extremity of the umbonal beak, gradually widens as it approaches the front. Ventral valve with a wide shallow mesial sinus, originating at the extremity of the beak, and widening as it approaches the rounded front; beak small, incurved; area narrow, with a triangular fissure in the middle. Surface of valves ornamented with numerous angular, irregular, often bifurcating ribs, and concentric lines of growth. Inside the ventral valve an exceedingly short vertical septum supports a small wide triangular chamber, formed by the quickly converging dental plates. Inside the dorsal valve there is a narrow hinge-area, with a triangular depression in the middle, formed by two small rapidly converging (but not united) socket-plates, the inner extremities of which are prolonged into free, narrow, crura, sometimes three and four lines in length. Under these, near the umbo of the shell, are two elongated pear-shaped impressions, due to the adductor or oclcluser muscles, divided in the middle by a central ridge. Numerous pits (rough tubercules on the cast), probably ovarian markings, surround these scars. Three specimens measured—

Length 2 inches 4 lines, width 2 inches 5 lines, depth 1 inch 1 line.

"	2	"	1	"	"	2	"	8	"
"	1	"	4	"	"	1	"	2	"

Obs. The history of this variable and interesting species may prove valuable as exemplifying the difficulties at times experienced by naturalists in arriving at the correct identification of some of our most characteristic species. In 1839 J. de C. Sowerby first noticed the shell as a distorted cast of a large *Spirifer* or *Orthis*, nearly three inches in length, to which he applied the name of *Spirifer liratus*, giving as its locality the "Caradoc sandstone" and "Llandeilo flags" of Marloes Bay, Pembrokeshire. Mr. Sowerby's specimen was very imperfect, merely a portion of the cast of a distorted valve; and the position was subsequently corrected by Mr. Salter in 'Siluria.' In 1846 Prof. McCoy gave a short but correct description and reduced figure of a valve of the same species (see Pl. XX, fig. 8) under the designation of *Spirifer ovatus*, remarking that it is the largest Silurian *Spirifer* with which he is acquainted. Prior, however, to this date, I should have observed that the same species had (in 1842) been described and figured by Hisinger, under the designation of *Cardium multisulcatum*. In 1848 M. de Verneuil mentions it as a *Spirifer*, retaining Hisinger's specific name; and in the same year Messrs. Phillips and Salter refer to this shell under the designation of *Orthis liratus*. In 1852, while I was preparing the "General Introduction" to the present work, Mr. Salter called my attention to this shell, as well as to *Pent. lens*, suggesting that they should be grouped as a section of *Pentamerus*, presenting well-marked internal characters, at once distinguishing them from true *Pentameri*, such as *P. Knightii*, *P. galeatus*, *P. linguifer*, &c. A description of these internal characters will be found in p. 54, pl. vii, fig. 118, of the above-mentioned "Introduction," as well as in p. 227 of my late friend Dr. S. P. Woodward's excellent 'Manual of the Mollusca,' published in 1854. At p. 229 of the second edition of 'Siluria,' (1859) Mr. Salter, to whom Sir Roderick Murchison had confided the revision and notes of the fossil data in his work, observes, while speaking of the Brachiopoda of the Llandovery rocks, that "The *Pentameri* are, however, the characteristic fossils, which impart to this 'zone its peculiar and distinct facies. No less than five species, whether smooth or only slightly ribbed, occur, and of these *P. oblongus* is the best known and the most widely spread. This typical shell is easily distinguished from the other species, *P. lens* and *P. liratus*, by the great length of the mesial septum, which in these latter is quite a short appendage to the V-shaped chamber. The two longitudinal plates, also, which divide the upper valve, are peculiar to this species; whilst in *P. lens* they are very short, and in *P. liratus* are reduced to a pair of processes which pass inwards, but do not show upon the surface of the cast."

In 1860 Dr. Lindström describes the same shell as *Cyrtina? multisulcata*; but soon afterwards, recognising his mistake, he identified his Gothland shell with *Pentamerus liratus*. Lastly, Mr. Billings, availing himself of the differential characters pointed out by Salter, proposed for such shells as *P. liratus*, *P. lens*, and some other Canadian and American species, the generic designation of *Stricklandia*, and which he subsequently altered to *Stricklandinia*. This I will retain as a section of the large genus

Pentamerus, and in which, I trust, the species under description will find a permanent home.

As already stated, *Stricklandinia lirata* varies greatly in its external shape, and this will be best understood by a glance at Pl. XX, wherein are represented some of the best examples of this species I have been able to assemble from our British collections. The size and regularity of the ribs are especially variable in different specimens, as well as the length of the hinge-line. In Sweden the shell has been found in a perfect condition; but in our British rocks we rarely find any portion of the shell itself preserved. Very good casts, however, especially of the interior, are common, and in those belonging to the dorsal valve (as may be seen in Pl. XX, fig. 11) there exist two elongated pits (the casts of the crural processes), whose length can be easily ascertained by the introduction of a pin or needle.

Position and Locality. *Stricklandinia lirata* appears to range from the Lower Llandovery to the lowest portion of the Wenlock series. It occurs in the May Hill Sandstone of Howler's Heath, south end of the Malverns; also near (north-east of) Chirbury; at Nash Scar, Presteign; Huntley Hill; Llangadock, South Wales, &c. Sir R. I. Murchison found it in the Woolhope beds of Woolhope; and Mr. Salter found it in the lowest Wenlock beds of Marloes Bay and Marloes Mill (Survey Catalogues).

In Ireland it occurs in Lower Llandovery grey slate at Cappacorogue, Cong, Galway; and in higher beds at Uggool, Ballaghaderreen, Mayo.

Abroad, Dr. Lindström found finely preserved examples in the "Wisby group" of Gothland. In North America the Geological Survey of Canada obtained *St. lirata* at East Point, South-West Point, Heath Point, and the Jumpers, in the Island of Anticosti.

STRICKLANDINIA LENS, *J. de C. Sow.* (sp.). Pl. XIX, figs. 13—23.

ATRYPA LENS, *J. de C. Sowerby.* Sil. Syst., pl. xxi, fig. 3, 1839.

SPIRIFER ? LEVIS, *Id.* Ib., pl. xxi, fig. 21. (Not *Pentamerus laevis*, *J. Sow.*, Min. Con., pl. xxviii, fig. 2; nor *Pent. laevis*, *J. de C. Sow.*, Sil. Syst., xix, fig. 9; *P. laevis* being the young of *Pent. oblongus*.)

PENTAMERUS LENS, *M'Coy.* Brit. Pal. Foss., p. 209, 1852.

— MICROCAMERUS, *M'Coy.* Annals and Mag. of Nat. Hist., 2nd ser., vol. viii, p. 290; and Brit. Pal. Foss., p. 210, 1859.

— LENS, *Morris.* Cat. of Brit. Foss., p. 142, 1854.

— — *Salter.* Siluria, 2nd ed., p. 100, Foss. 14, fig. 1, and pl. viii, figs. 9, 10, 1859.

STRICKLANDIA — *Id.* Billings, Canadian Journal, p. 51, fig. 88, 1861.

STRICKLANDINIA — *Billings.* Cat. Sil. Anticosti, Geol. Survey of Canada, p. 45, 1866.

PENTAMERUS — *Salter.* Mem. Geol. Survey, vol. iii, pp. 276 and 360, 1866.

Spec. Char. Longitudinally oval, sides and front rounded, greatest width nearer the beak. Valves moderately and almost equally convex or deep. Hinge-line nearly straight, and less than the width of the shell. In the dorsal valve there is a rounded mesial fold, of moderate elevation, which in front forms a convex lobe. In this valve

the beak is incurved; the area narrow, triangular, and divided in the middle by an open fissure. Surface smooth, marked only with concentric lines of growth and obscurely radiating fine longitudinal striæ. Inside the ventral valve the two converging dental plates are exceedingly small, supported by an equally small vertical septum. In the dorsal valve there are in the middle of the narrow hinge-area two small converging, but not united plates; and close to the hinge are two small elongated scars, due to the adductor or ocluclosor muscles. Two specimens measured—

Length 2 inches 7 lines, width 2 inches 1 line, depth 10 lines.

„ 1 „ 9 „ „ 1 „ 7 „ „ 10 „

Obs. In outline this species much resembles *Pentamerus oblongus*; but it is much flatter and its beak not so much incurved; and its area and straight hinge-line also distinguish it. Again, the external resemblance is in strong contrast with the interior; for *St. lens* possesses the small plates of *Stricklandinia*, and not the large ones of *Pentamerus*; I am therefore surprised that Prof. M'Coy should say, at p. 210 of his 'British Pal. Fossils,' that *St. lens* has exactly the same internal structure as *P. oblongus*; and this remark inclines me to surmise that, while describing his so-termed *P. lens*, he had before him a specimen or cast of *P. oblongus*. Exteriorly, *St. lens* is at once distinguished from *St. lirata*, both by its external and internal characters; thus, there are no cavities in the cast wherein a needle's point can be introduced, as in *St. lirata*; and, although at first sight there may not appear to be much difference in the respective internal casts, this character will at once serve to distinguish them. Prof. M'Coy's *Pentamerus microcamerus* is nothing more than a synonym of *Stricklandinia lens*, and, as that author observes, is quite different from *P. lavis*, Sow., to which he supposed Mr. J. de C. Sowerby had erroneously referred the fragment drawn in pl. xxi, fig. 12, of the 'Silurian System.' In a foot-note to p. 229 of the second edition of Murchison's 'Siluria,' Mr. Salter observes that "the *P. microcamerus* (of M'Coy) appears not to be distinct from *P. lens*;" and on a recent examination of the Silurian fossils in the Woodwardian Museum at Cambridge, Mr. Salter and myself found an undoubted specimen of *Stricklandinia lens* from the Lower Llandovery of Mandinam, labelled by M'Coy *Pentamerus microcamerus*, and in another drawer, a specimen of *St. lirata* from May Hill, also labelled by M'Coy *P. microcamerus*. This name, therefore, may be eliminated from our lists.¹

Position and Locality. *Stricklandinia lens* occurs in the Lower and Upper Llandovery rocks, and is equally abundant in both. In the *Lower Llandovery* Mr. Salter has identified it from Mandinam, Goleugoed, and Gorllwyn-fawr, in the Llandovery district; Priory Mill, Haverfordwest; Cefn, near Butington; Mathyrafal, near Meifod; Rhyader; and Pumpsant, Carmarthenshire. In the *Upper Llandovery* at Norbury, Bishops

¹ I may here mention that, at Prof. Sedgwick's request, Mr. Salter has recently carefully re-examined those Silurian fossils described by Prof. M'Coy which are in the Woodwardian Museum, Cambridge; and all the original labels have been preserved in those cases where the localities or names of the species have undergone revision. The nomenclature of the beds is, of course, that of Prof. Sedgwick.

Castle; Bromsgrove, Lickey; Worcester Beacon, Malvern; May Hill; Huntley Hill; Chirbury; Gunwick Mill, Gullet Wood, Howler's Heath, &c., west of the Malverns; Avery Green, and Woodford Green, near Tortworth; at Mandinam, Pen-lan, and Castell-craig-gwyddon, Llandovery; Trecoed, Builth, &c.

Mr. Salter mentions that at May Hill and in the Malverns *St. lens* is more abundant than *Pent. oblongus*; *St. virata* being found also in the same beds. In the Shropshire and western districts it is less so.

In the Geological Survey Reports of Canada Mr. Billings quotes *St. lens* from Southwest Point, and the Jumpers, both in the Island of Anticosti.

Genus—RHYNCHONELLA, Fischer, 1809.

Ref.—“Introduction,” p. 93.

This excellent genus has been so often described in the present work, that it will not be necessary to again refer to the subject, further than to mention that since the publication of my “General Introduction” the anatomy of one of its most characteristic living types has been admirably described and illustrated by Mr. Albany Hancock,—in the ‘Philosophical Transactions’ for the year 1858.

Much still remains to be done before the multitude of species at present referred to the genus by different authors can be properly weeded, and classed according to the modifications presented by their interiors. Indeed, Prof. Hall has already detached from it certain forms upon which his genus *Eatonia* is founded; and it is very probable that, when the interiors of more of the species shall have been discovered and properly studied, it may be necessary to divide the numerous species into several minor sections, or even genera. In all the published lists of Silurian *Rhynchonellæ* a number of species which do not belong to the genus have been provisionally admitted by several palæontologists, and necessarily so until the interiors are known; and although I believe I have successfully detached some of these species, and placed them in their proper genera, there still remain a few of whose correct position I feel very uncertain, and they must, I suppose, be temporarily allowed to encumber the genus.¹ In the second volume of the ‘Memoirs of the Geological Survey’ Prof. Phillips proposed the generic designation of *Hypothyris* for the plaited *Terebratulæ*; and in his ‘British Palæozoic Fossils’ Prof. McCoy adopts that of *Hemithyris* for our British Silurian species of *Rhynchonella*; these designations, however, have been found to be synonyms of the genus distinguished by Fischer de Waldheim in 1809.

¹ It is a useful canon in palæontology, that when, from imperfect materials, the exact genus of a new form cannot be ascertained, the describer shall place it in some leading and well-known group, such as *Rhynchonella*, *Spirifera*, *Terebratula*, &c., instead of under a new but doubtful name. By this rule frequent changes are avoided, the leading genus being understood to be a temporary storehouse for indistinct but allied forms.—J. W. S.

RHYNCHONELLA CUNEATA, *Dalman* and *Hisinger* (sp.). Pl. XXI, figs. 7—11.

TEREBRATULA CUNEATA,	<i>Dalman</i> .	K. Vet. Akad. Handl., p. 141, pl. vi, fig. 3, 1827.
—	<i>Hisinger</i> .	Bidrag till Sveriges Geognosi, part iv, p. 239, pl. vi, fig. 3, 1828.
—	<i>Id.</i>	Lethæa Suecica, p. 81, pl. xxiii, fig. 5 a, b, 1837.
—	<i>Angelin</i> .	Mus. Pal. Suec., 1838.
—	<i>J. de C. Sow.</i>	Sil. Syst., p. 625, pl. xii, fig. 13, 1839.
ATRYPA	<i>M'Coy</i> .	Synopsis of Sil. Foss. of Ireland, p. 39, 1846.
TEREBRATULA	<i>De Verneuil</i> .	Note sur le parallelisme des Dépôts Paléozoïques, Bul. Soc. Géol. Fr., 2nd ser., vol. iv, p. 698, 1847.
—	<i>Barrande</i> .	Silurische Brach. aus Böhmen; Natur. Abhandl., vol. i, p. 80, pl. xvii, fig. 11, 1847.
—	<i>Davidson</i> and <i>De Verneuil</i> .	Bull. Soc. Géol. Fr., 2nd ser., vol. v, pp. 331 and 346, 1848.
—	<i>Bronn</i> .	Index Pal., p. 1233, 1848.
SPIRIFERINA	<i>D'Orb.</i>	Prodrome, vol. i, p. 42, 1849.
HYPOTHYRIS	<i>Phillips</i> and <i>Salter</i> .	Mem. Geol. Survey, vol. ii, part 1, p. 280, 1848.
TEREBRATULA	<i>Salter</i> .	Quart. Journal Geol. Soc., vol. vii, p. 172, 1851.
ATRYPA	<i>J. Hall</i> .	Palæont. New York, vol. ii, p. 276, pl. lvii, fig. 4 a—r, 1852; and <i>Rhynchonella cuneata</i> , 12th Annual Report of the Regents, &c., p. 77, 1859.
—	<i>Morris</i> .	Catalogue of British Fossils, p. 132, 1854.
RETZIA	<i>Salter</i> .	Siluria, 2nd ed., pl. xxii, fig. 8, 1859.
RHYNCHONELLA	<i>D'Eichwald</i> .	Lethæa Rossica, vol. i, p. 765, 1859.
—	<i>Lindström</i> .	Öfv. K. Vet. Akad. Förhandl., p. 365, 1860.

Spec. Char. Triangular or cuneiform, longer than wide, broadest anteriorly, or near the front, posteriorly tapering into an almost angular beak. Valves usually depressed or moderately convex; beak of ventral valve more or less elongated or produced; foramen circular, placed under the extremity of the slightly incurved beak, margined, and separated to a greater or lesser extent from the hinge-line by a deltidium in two pieces; lateral portions of the beak much depressed, forming broad, flattened, and slightly concave spaces, which extend to fully half the length of the shell or more; sinus wide and shallow, commencing at a short distance from the beak, and extending to the front. Dorsal valve somewhat deeper or more convex than the opposite one, flattened at the umbone, but soon after forming a slightly raised broad mesial fold, which extends to the front. Surface of each valve ornamented with from ten to fourteen angular ribs, of which four or five compose the fold, while three or four occupy the sinus, the surface being also regularly crossed by numerous fine, nearly equidistant, slightly raised, concentric lines or ridges. Two specimens measured—

Length 11, width 9, depth 6 lines.

„ 10 „ 9 „ 6 „

Obs. Although some uncertainty seems to have prevailed amongst palæontologists as to the genus to which Dalman's species should be referred, all the evidence in my possession would tend to confirm its position in the genus *Rhynchonella*. The form of the shell is very like that of several well-known species of the genus, such as *Rh. angulata*, Linn., &c. When quite young (fig. 11) there is no apparent mesial fold, the dorsal valve being depressed along the middle, with interspaces of equal width between the ribs. The foramen also is then contiguous to the umbone of the opposite valve, while the narrow deltidial plates which margin its lateral portions are disunited in the middle; but as the shell acquires age the mesial fold becomes developed, and the beak more or less elongated, so that the foramen is in many specimens at a considerable distance from the hinge-line, as seen in figs. 7, 9, 10. At page 276 of vol. ii of the 'Pal. of New York,' Prof. Hall remarks that this species presents considerable variety of form and proportions.

It appears difficult to make out whether it was Dalman or Hisinger who first gave the name of *cuneata* to this species. Dr. Lindström thinks it was the latter, as in the 'Bidrag til Sveriges Geognosi,' part iv, p. 239, he mentions *Terebratulæ cuneata*, D., and gives a drawing of it in his pl. vi, fig. 3. The D. evidently means Dalman; but if the memoir of Dalman had been then published Hisinger would have cited the plate and figure of the last-named author. It is probable that Hisinger had seen Dalman's manuscript, which was ready in 1827, but not published until 1828. However, it is also strange to find in Dalman's memoir, 'K. Vet. Akad. Handl.,' p. 141, the species referred to as Hisinger's, while in the 'Lethæa Suecica' Hisinger again restores it to Dalman. The only way I can see to settle the authorship will be to assign it to both.

I do not know what to make of M'Coy's *Atrypa seacostata* ('Synopsis Sil. Foss. of Ireland,' p. 41, pl. iii, fig. 30, and fig. 13 of our Plate), which is stated to be "Triangular, depressed; front subtruncate, sides straight, margin very obtuse; surface with six angular radiating ribs. Loc.—Lettershanbally, Leenane, County Galway, and in the sandstone of Shanballymore, Oughterard, County Galway, Ireland." I have seen the original specimen, kindly lent to me by Sir R. Griffith; it is an obscure fragmentary fossil, and may, perhaps, be an imperfect specimen of *Rh. cuneata*.

Position and Locality. *Rh. cuneata* occurs in the Llandoverly rocks, but principally in the Wenlock limestone. In the Woolhope limestone of Hay Head, near Walsall; Wenlock limestone and shale of Dudley, Benthall Edge, Lincoln Hill, &c.; Canwood and Dormington Wood, Woolhope; Hill End and Callow Farm, Abberley; Rock Farm, May Hill.

In Scotland it is found in the shape of imperfect casts in the Llandoverly rocks of Ardmillan, Thrave, and Mullock Hill, in Ayrshire; but I am not certain that the identification is correct.

In Ireland M'Coy mentions Shanballymore, Oughterard (Sir R. Griffith's Collection).

It is common in the Island of Gothland. It was also found by Barrande in the Silurian rocks of Bohemia. D'Eichwald quotes it from the banks of the River

Smotrytsch, near the village of Laskovsky, in Podolia; also from the Island of Oesel. In America it is stated by J. Hall to occur in the shale at Lockport in the Niagara Group, also on the Niagara River above Lewiston.

RHYNCHONELLA STRICKLANDII, *J. de C. Sow.* (sp.). Pl. XXI, figs. 1—6, and 28.

TEREBRATULA	STRICKLANDII,	<i>J. de C. Sow.</i>	Sil. Syst., pl. xiii, fig. 19, 1839.
—	CRISPATA,	<i>Id.</i>	Ib., pl. xii, fig. 11, 1839.
—	STRICKLANDII,	<i>Dav.</i>	Bull. Soc. Géol. France, 2nd ser., vol. v, p. 329, 1848.
HYPOTHYRIS	—	<i>Phillips and Salter.</i>	Mem. Geol. Survey, vol. ii, part 1, p. 282, 1848.
HEMITHYRIS	—	<i>D'Orbigny.</i>	Prodrome, vol. i, p. 37, 1849.
—	—	<i>M'Coy.</i>	Brit. Pal. Foss., p. 206, 1852.
RHYNCHONELLA	—	<i>Morris.</i>	Catalogue of British Fossils, p. 146, 1854.
—	—	<i>Salter.</i>	Siluria, 2nd ed., pp. 250 and 544, pl. xxii, fig. 11, 1859.
—	—	<i>Lindström.</i>	Öfv. K. Vet. Akad. Förhandl., p. 366, 1860.

Spec. Char. Transversely ovato-subtrigonal, very convex, somewhat wider than long, sides and front rounded. Dorsal valve gibbous or ventricose, slightly flattened at the umbone, pinched in or concave laterally; mesial fold wide, not commencing until at some distance from the umbone, and becoming more prominent as it approaches the front. Ventral valve not quite as deep or convex as the dorsal; sinus wide and rather deep; beak very small, depressed, and incurved over, and appressed to the umbone of the dorsal valve; lateral spaces wide, concave, and indenting by a convex curve the corresponding margin of the opposite valve. Surface of each valve ornamented with from twenty-eight to thirty-four narrow, simple, angular ribs, which radiate from the beaks to the margins, and of which six or eight occupy the fold and sinus. Two specimens measured—

Length 15, width 16, depth 13 lines.

„ 12 „ 13½ „ 8 „

Obs. This well-marked species varies a good deal according to age and circumstances. When quite young it is much depressed, the fold and sinus being hardly apparent, but with age the shell becomes globose, the ventral valve often ventricose, especially posteriorly, while the fold acquires its greatest elevation near the front. The smallness of the flattened appressed beak, and the concave or pinched-in lateral portions of the beak and umbone, give to this species a well-marked and easily recognizable character. Some internal casts show beautifully the muscular and vascular impressions (fig. 6). At p. 1231 of his 'Index Palæontologicus,' Bronn places *Rh. Stricklandii* among the synonyms of *Rh. borealis*; but this is quite a mistake, as a glance at their respective figures will at once show; and it is probable that the distinguished German palæonto-

logist was not acquainted with our British species, nor does it appear to be a common fossil, except in a few localities in England and abroad.

The original specimen of Sowerby's "*Terebratula crispata*" is in the Museum of the Geological Society. It is a moderately convex example of *T. Stricklandii*, and was so identified by Mr. Salter some years ago while rearranging Sir R. Murchison's Silurian collection, presented to that Society.

Position and Locality. *R. Stricklandii* appears to be rare in the Woolhope beds; common in the Wenlock limestone and shale; and rare again in the Aymestry limestone. It occurs at Nash Scar, Presteign, in Woolhope beds. In Wenlock shale at Gaer-coed, Tucking Mill, Craig-y-coed, and Bryn Craig, in the Usk district; in Wenlock limestone at Hobbs, Longhope, and the Rock, May Hill district; Croft, and east of Ledbury, Malvern district; Rushall Canal, near Walsall; Dudley; Sedgley; Canwood, and Dormington, near Woolhope. At Llanbadoc, in Aymestry limestone, Usk district (Phillips and Salter). I am not acquainted with any Scottish or Irish example. Abroad it was met with by Dr. Lindström in the Island of Gothland, but there it appears to be exceedingly rare.

RHYNCHONELLA WILSONI, *J. Sowerby* (sp.). Pl. XXIII, figs. 1—9.

- ? ANOMIA subglobosa posticè dupliciter striata, *Linné*. Mus. Tessinianum, p. 88, pl. v, fig. 6, 1753.
- ? — LACUNOSA, *Linné*. Syst. Nat., xii ed., vol. i, part 2, p. 1153, 1767.
- TEREBRATULA WILSONI, *J. Sowerby*. Min. Con., vol. ii, p. 38, pl. cxviii, fig. 3, &c., 1816.
- ANOMITES LACUNOSUS, *Wahlenberg*. Nova Acta R. Soc. Upsaliensis, p. 67, 1821.
- TEREBRATULA LACUNOSA, *Dal.* Vet. Akad. Handl., p. 139, pl. iv, fig. 1, 1828.
- WILSONI, *Von Buch*. Ueber Terebrateln, p. 47, 1834.
- LACUNOSA, *Hisinger*. Lethæa Suecica, p. 80, pl. xxiii, fig. 3, 1837.
- WILSONI, *J. de C. Sow.* Sil. Syst., p. 615, pl. vi, fig. 7, 1839.
- CREBRICOSTA, *Id.* Ib., pl. xiii, fig. 18, 1839.
- WILSONI, *Angelin*. Mus. Pal. Suec., 1838.
- PENTAGONA, *J. de C. Sow.* Sil. Syst., pl. v, fig. 21, 1839.
- WILSONI, *De Vern.* Geol. of Russia and Ural, p. 87, pl. x, fig. 8, 1845.
- ATRYPA — *McCoy*. Synopsis Sil. Foss. of Ireland, p. 42, 1846.
- TEREBRATULA — *De Verneuil*. Bull. Soc. Géol. Fr., 2nd ser., vol. iv, p. 699, 1847.
- — *Barrande*. Sil. Brach. Böhmen; Naturw. Abhand., p. 82, pl. xviii, fig. 4, 1847.
- — *Bronn* (parte). Index Palæont., p. 1255, 1848.
- — *Dav. and De Vern.* Bull. Soc. Géol. Fr., 2nd ser., vol. v, pp. 328 and 346, 1848.
- HYPOTHYRIS — *Phillips and Salter*. Mem. Geol. Survey, vol. ii, part 1, p. 282, 1848.
- HEMITHYRIS — *D'Orbigny*. Prodrome, vol. i, p. 37, 1849.

- RHYNCHONELLA WILSONI, *Dav.* Annals and Mag. of Nat. Hist., 2nd ser., vol. ix, pl. xiii, 1852.
- HEMITHYRIS — *McCoy.* Brit. Pal. Foss., p. 207, 1852.
- RHYNCHONELLA — *Morris.* Catal. of British Fossils, p. 148, 1854.
- ANOMIA LACUNOSA, *Hanley.* Ipsa Linnæi Conchylia, p. 128, 1855.
- RHYNCHONELLA WILSONI, *Schmidt.* Archiv Nat. Liv.- Ehst.- und Kurlands, vol. ii, p. 210, 1858.
- — *D'Eichwald.* Lethæa Rossica, vol. i, p. 762, 1859.
- — *Salter.* Siluria, 2nd ed., p. 545, pl. xxii, fig. 13, 1859.
- PENTAGONA, *Id.* Ib., p. 545, pl. xxii, fig. 3, 1859.
- CREBRICOSTA, *Id.* Ib., p. 544, pl. xxii, fig. 3, 1859.
- WILSONI, *Lindström.* Gottland Brach., p. 366, 1860.
- — *Salter.* Explan. Sheets 160, &c., Geol. Survey Ireland, p. 13, 1863.

Spec. Char. Subpentagonal, but generally cubical, and often sub-spherical, about as wide as long; sides and front rounded; valves almost equally gibbous, and often so much so that the shell is twice as deep as either long or wide, and presents, when viewed in front or in profile, an elongated oval shape. Dorsal valve somewhat flattened, or gently convex at the umbone, with a slight longitudinal depression or groove along its middle; in front abruptly deflected, and almost perpendicular before meeting the margin of the opposite valve; fold wide, nearly flat, and in the ordinary varieties not raised above the general convexity of the valve. Ventral valve flattened or slightly convex posteriorly, but in front abruptly deflected, and becoming almost perpendicular as it meets the acutely dentated margin of the dorsal valve; sinus wide, oblong, square, and nearly flat, very shallow, and scarcely defined on the surface; beak small, much incurved, and usually so much appressed to the umbone of the dorsal valve that no foramen is visible; beak-ridges strongly marked, leaving a concave space between them and the hinge-line. Surface of both valves ornamented with from thirty to forty small, usually simple ribs, of which from six to nine occupy the fold and sinus; the ribs are likewise usually divided or indented along the middle in their proximity to the serrated margin. On the inner surface of the dorsal valve, under the divided hinge-plate, is a mesial ridge of small elevation, which extends less than half the length of the valve, and divides the slightly marked muscular impressions. In the ventral valve a depressed median scar, longitudinal and oval, is surrounded by a large saucer-shaped muscular impression. Two large specimens measured—

Length 13, width 13, depth $11\frac{1}{2}$ lines.

“ 7 ” 7 ” 10 ” but the shell is usually smaller.

Obs. As this important Upper Silurian species has by some authors been referred to Linné's *Anomia lacunosa*, it will be desirable to search its history. In the twelfth edition of the 'Systema Naturæ,' p. 1153, 1767, Linné describes his *Anomia lacunosa* as follows:—"A. testa subrotunda multisulcata; valvulis apice plicatis; altera



PLATE XIII.

SILURIAN SPECIES.

Fig.

- 1—3 *a.* *Meristella* ? *crassa*, Sow. sp. 1. Exterior of dorsal valve. Lower Llandovery; Cefn-Rhyddan.
2. Internal casts of ventral valve. 2 *a.* Mould in gutta-percha from the same. Same Locality as fig. 1. (Murchison's original specimen.) Mus. Geol. Society. 3. Internal cast of dorsal valve. 3 *a.* An enlarged fig. from a mould in gutta-percha of the same cast. Mus. Geol. Soc.
- 4—4 *c.* „ *subundata* (*Hemithyris*, M'Coy). After the original figures in 'Brit. Pal. Foss.,' pl. i n, figs. 9, &c. Fig. 4, enlarged; 4 *a*, *b*, *c*, nat. size. (This shell is not very unlike in shape to some flattened specimens of *M. tumida*.) Woodwardian Museum, Cambridge.
- 5—5 *a.* *Athyris obovata*, Sow. 5. Nat. size. 5 *a.* A considerably enlarged interior of the ventral valve, to show the muscular and vascular impressions. Lower Ludlow. Collection of Dr. Holl.
- 6—6 *b.* „ ? *depressa*, Sow. 6. Nat. size. 6 *a*, *b.* Enlarged figures from a young but perfect example. Woolhope limestone. Road between Alfric and Crew Hill, Malvern.
- 7—9. *Meristella* ? *furcata* (*Terebratula*, Sow.). 7. Internal cast of ventral valve, nat. size. 7 *a.* The same enlarged. 7 *b.* A gutta-percha mould from cast, also enlarged. South of Bogmine, near Corndon Hill. This is the original specimen figured in 'Sil. System' (pl. xxi, fig. 16). 8, 9. Other casts (after the original figures).
- 10—13 *c.* *Retzia* ? *Barrandi*, Dav. A series of specimens, showing modifications in shape; from the Wenlock limestone of Dudley, Hay Head near Walsall, and Buildwas near Wenlock. 12 *a*, and 13 *a*, *b*, *c*, *d*, are enlarged illustrations.
- 14—22. *Atrypa* ? *Grayii*, Dav. A series of modifications of this singular shell, from the Wenlock limestone of Dudley, and Hay Head, near Walsall. Fig. 14 is the largest example hitherto found. Figs. 14 *a*, 15 *a*, 16 *a*, *b*, *c*, 17 *b*, 18 *a*, *b*, 19, 20, 21, and 22, are enlarged figures.
- 23—30 *a.* „ ? *hemispharica* (*Atrypa*, Sow.). A variety of specimens. 23. Copy of the original illustration in 'Sil. Syst.,' pl. xx, fig. 7. Upper Llandovery, May Hill. 24. Nat. size, and 24 *a*, *b*, *c*, enlarged, from the Upper Llandovery, Charfield Green. Mus. Geol. Survey. 25. From the Upper Llandovery, Ardmillan, Ayrshire. 26. Mullock Hill, Ayrshire. 27. Penkill, Ayrshire. 28. From Ankerdine, in May Hill sandstone. 29. Internal cast of ventral valve, nat. size, and 29 *a*, enlarged, from Penwhapple Glen, Ayrshire. 30 and 30 *a.* Internal cast of dorsal valve. Mus. Geol. Survey.
- 31—31 *b.* „ *Scotica*, M'Coy. After the figures in Brit. Pal. Foss., pl. i n, fig. 10. Mullock; Dalquoran; Woodwardian Museum, Cambridge.



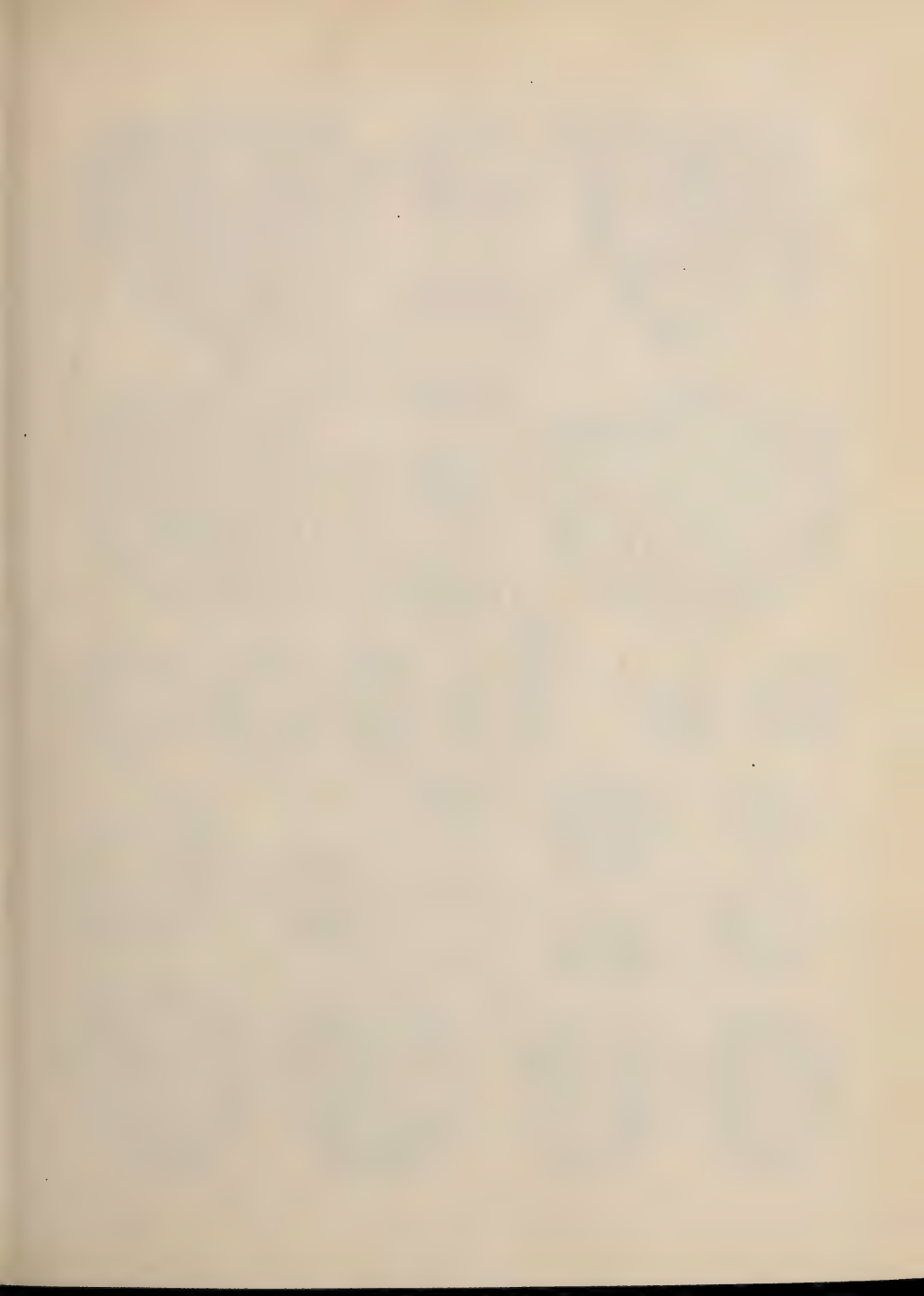


PLATE XIV.

SILURIAN SPECIES.

Fig.

1. *Atrypa reticularis*, Linn. Wenlock limestone, Rushall Canal. Specimen with one of its fringes almost entire.
2. " " Impression of a specimen with marginal fringe almost complete. Wenlock limestone, Marloes Bay. Mus. Geol. Survey, London.
3. " " Small specimen with fringe. Wenlock shale, Pentland Hills.
- 4, 4 a. " " From the Wenlock limestone, Dudley. 4 a, enlarged.
5. " " A specimen with fringe viewed in profile. Rushall Canal, Walsall.
- 6 to 11. " " A series of specimens of different ages and forms, from Wenlock limestone, Dudley.
12. " " A variety, with small numerous ribs. Dudley.
13. " " Ventral valve greatly enlarged, from a specimen in which the ribs are unusually angular, and often bifurcating. Wenlock shale; Mus. Geol. Survey, London.
14. " " (var. *orbicularis*, Sow.). Penkill Hill, Girvan, Ayrshire.
15. " " Interior of dorsal valve (minus the spiral lamellæ), to show the hinge-plate and muscular impressions. Wenlock limestone, Dudley.
[A full account of the internal appendages, by Mr. R. P. Whitefield, is given in the 19th Report on the New York State Cabinet, Dec., 1866.¹]
16. " " Interior of ventral valve. Dudley.
17. " " A fine internal cast of dorsal valve. Wenlock limestone, Usk. Museum of the Geological Society, London.
- 18, 19. " " 18. Interior of ventral valve, from the Upper Llandovery, Huntley Hill. Mus. Geol. Survey, London. 19. Internal cast; same locality.
20. " " Silicified cast, the spaces occupied by the spiral coils being left empty. Wenlock limestone, Malvern; Mus. Geol. Survey.
- 21, 22. " " Young shells with few ribs, approaching in character to *A. aspera*. Wenlock limestone, Dudley.

¹ "The internal appendages of the genus *Atrypa* have been known to consist of a pair of spiral cones, placed side by side, with their apices directed towards the cavity of the dorsal valve. By carefully cutting and preparing favorable specimens, I have found that in place of the short crural processes so often figured, there is an entire and continuous loop connecting the spiral cones, having its connection with the spiral ribbons at a point relatively much nearer to their origin on the hinge-plate: still more distant, however, than the points figured by Mr. Davidson and others. This loop, so far as yet observed, is confined to the rostral or posterior part of the shell, and never passes over or in front of the spires, as in Prof. Hall's genus *Zygospira*. From its origin on the posterior portion of the first volutions of the spires, the loop curves gently forward and upward; the central or elevated portion lying between and behind the cones, and forming a more or less abrupt curve, or prolonged into a point directed towards the dorsal valve," &c.

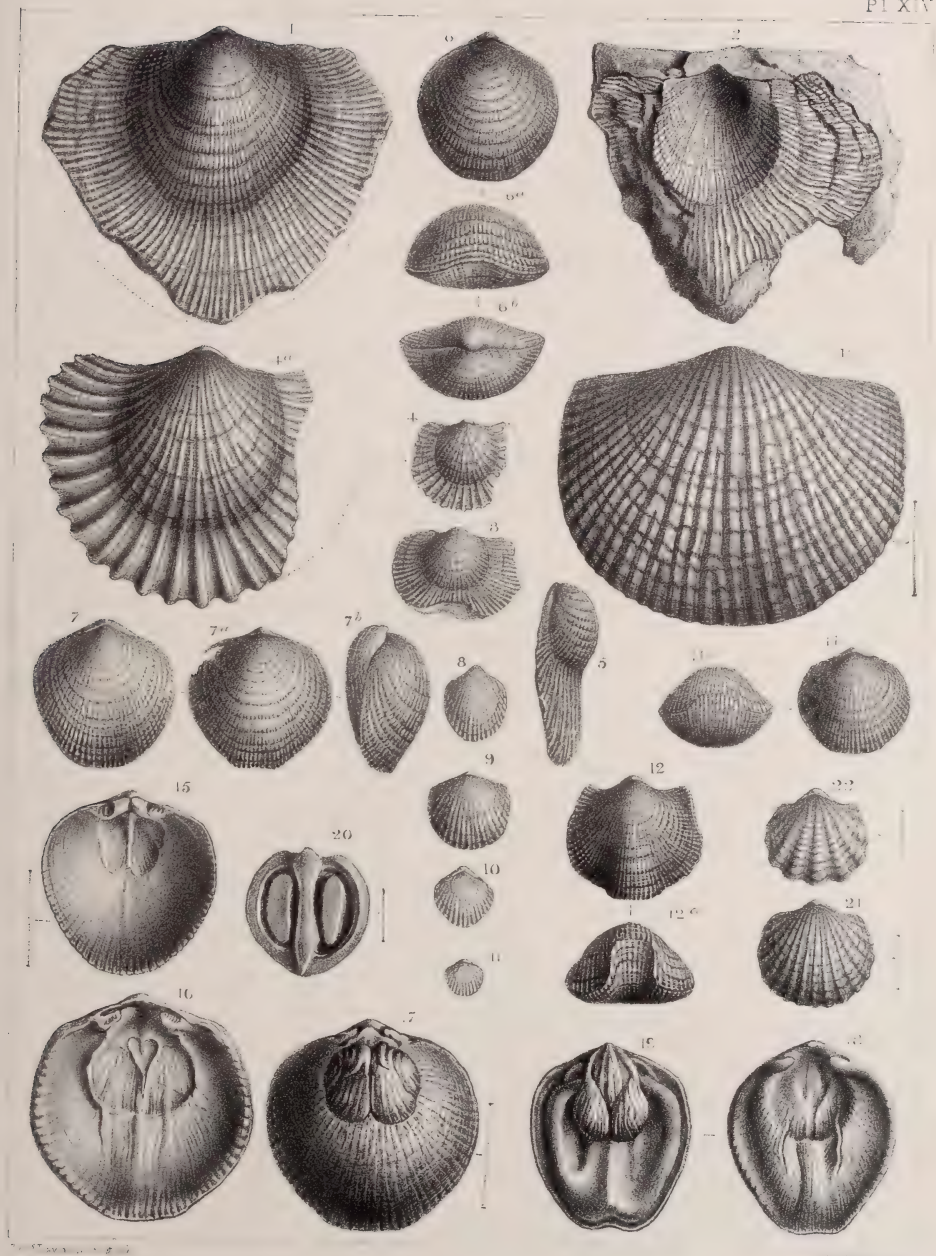


PLATE XV.

SILURIAN SPECIES.

FIG.

- 1—2 *c.* *Atrypa marginalis*, Dalman. Figs. 1, 1 *a*, 1 *b*, 1 *c*, nat. size. 2 *a*, *b*, *c*, the same, considerably enlarged. Wenlock limestone, Dudley. 1 *d*, a portion of the shell enlarged, to show the close concentric lines or ridges.
- 3—8. *Atrypa imbricata*, Sow. 3 and 3 *a*, nat. size; Wenlock limestone, Dudley. 4 *a*, *b*, *c*, a specimen considerably enlarged; Dudley. 4 *d*, a portion of shell still more magnified. 5, 5 *a*, 6, 6 *a*, two flatter varieties. Wenlock limestone, Dudley. 7, a large old specimen from the Caradoc limestone, Chair of Kildare; Mus. Geol. Survey, London. 8, nat. size, from Penkill, near Girvan, Ayrshire.
- 9—11. *Pentamerus? rotundus* (*Atrypa rotunda*, Sow.). 9, 9 *a*, 9 *b*, drawn from the specimen originally figured in 'Sil. Syst.,' pl. xiii, fig. 7. Wenlock limestone; Wenlock Edge; Mus. Geol. Soc., London. 9 *c*, 9 *d*, the same enlarged. 10—10 *c*, a larger specimen, from the Woolhope limestone, near Malvern; Worcester Nat. Hist. Museum. 11, another specimen; same locality; Collection of Dr. Holl.
12. ,, ,, ? Internal cast of the ventral valve of a specimen so named by Prof. M'Coy. Kilbride, Cong. County Galway. Sir R. Griffith's Collection.
- 13—22. *Pentamerus galeatus*, Dalm. A series of specimens, showing the principal modifications in form assumed by this very variable species; all derived from the Wenlock limestone and shale near Dudley. Figs. 15, 15 *a*, are after Sowerby's illustration, 'Sil. Syst.,' pl. xii, fig. 4.
23. ,, ,, Profile view of the interior, one half of the valves having been removed.

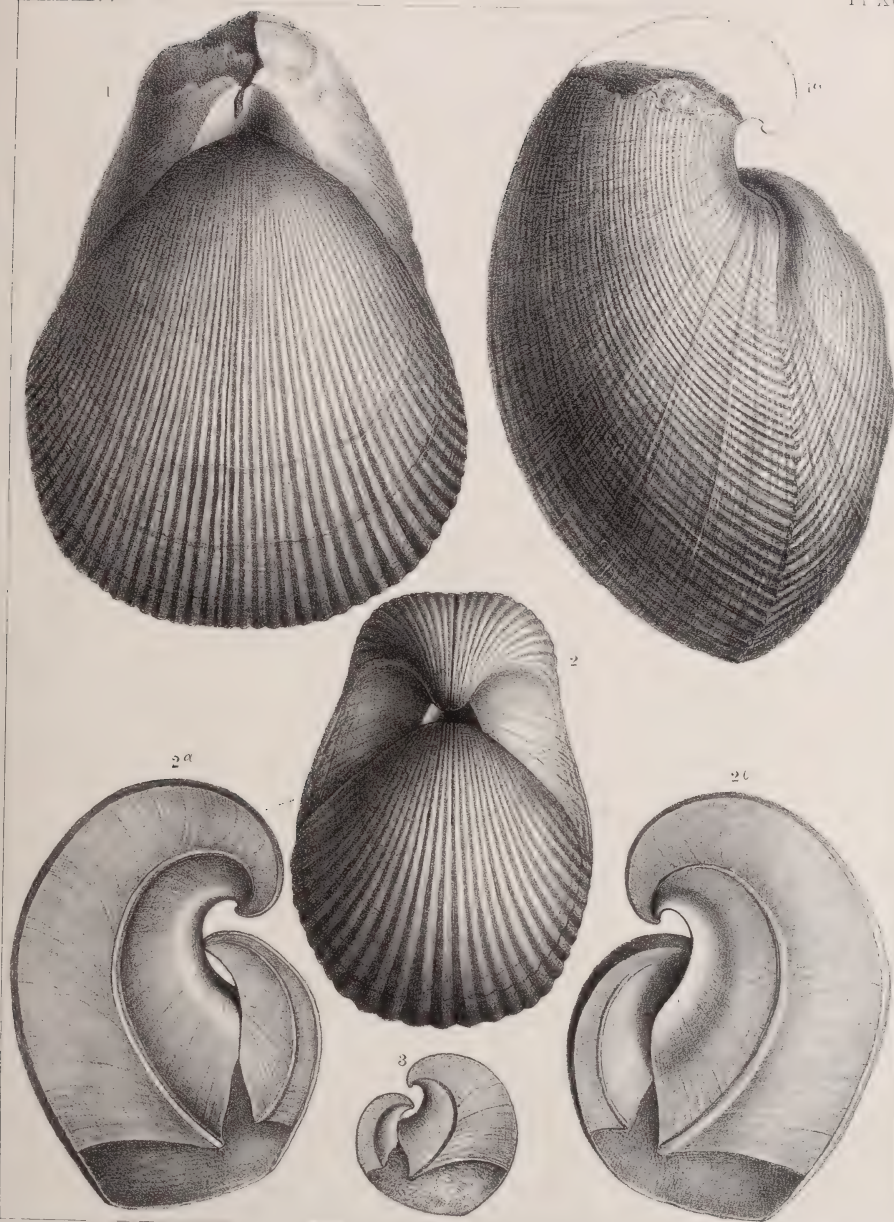


PLATE XVI.

SILURIAN SPECIES.

FIG. 6

- | | | |
|---------|-----------------------------------|--|
| 1, 1 a. | <i>Pentamerus Knightii</i> , Sow. | A large example found by Dr. Lloyd in the Aymestry limestone of Mocktree, near Ludlow. Ludlow Museum. |
| 2. | „ „ | From the Aymestry limestone, N.E. of Leintwardine. Museum Geological Survey. 2 a and 2 b, the same specimen, longitudinally divided into two parts, to show the position of the internal plates. |
| 3. | „ „ | Longitudinal half of a specimen, to show internal plates. From Aymestry limestone, Bodenham, Woolhope. Museum of the Geological Survey, London. |



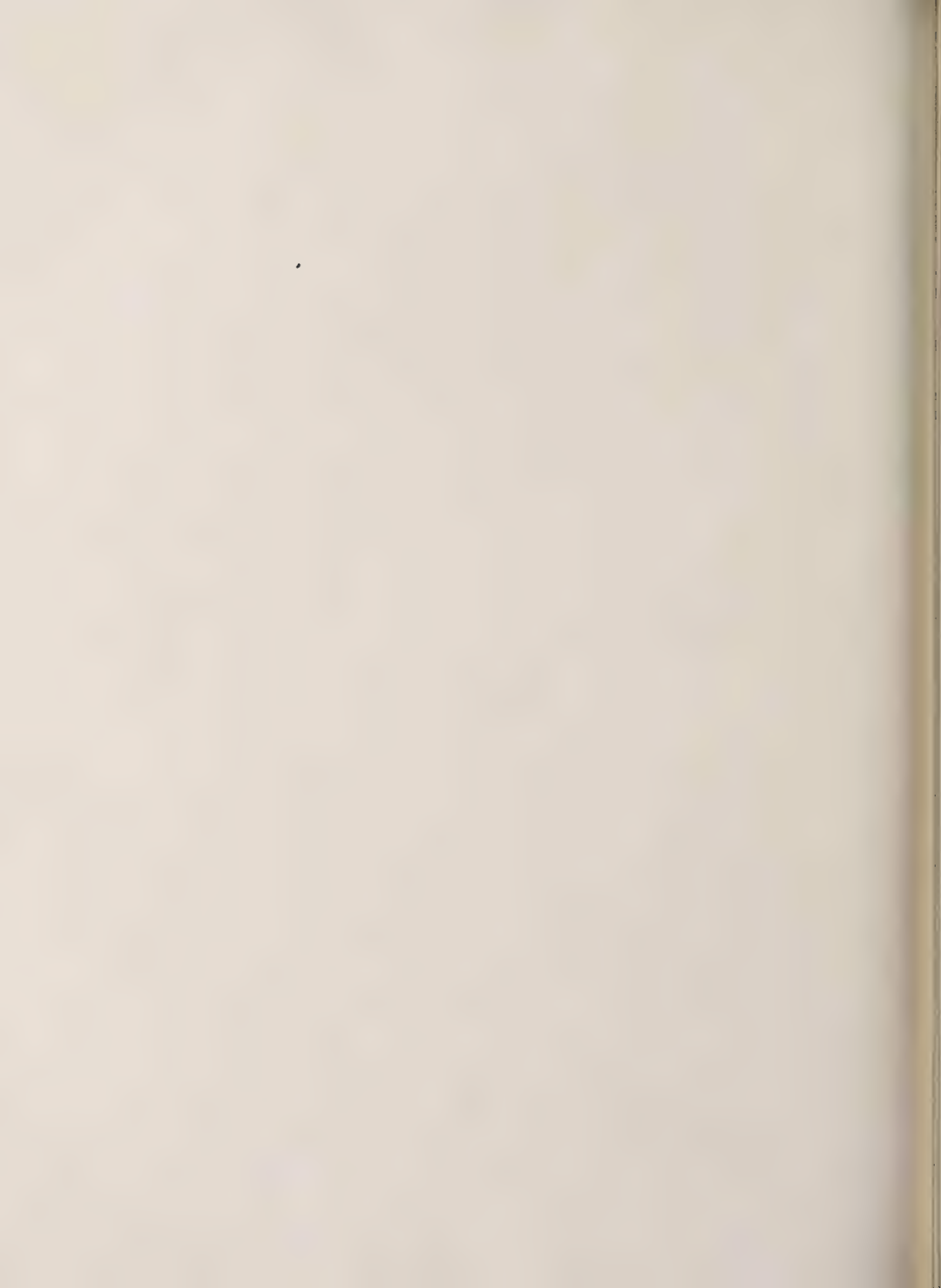


PLATE XVII.

SILURIAN SPECIES.

FIG.

- | | | |
|------------------------------|-----------------------------------|--|
| 1, 1 <i>a</i> , 1 <i>b</i> . | <i>Pentamerus Knightii</i> , Sow. | Aymestry limestone, Aymestry. |
| 2. | " " | A very elongated example. Aymestry limestone, Mocktree, near Ludlow. |
| 3. | " " | In this specimen a portion of the dorsal valve has been removed, to show the V-shaped chamber of the ventral valve. Aymestry limestone, N.E. of Leintwardine. Mus. Geol. Survey. |
| 4. | " " | A very transverse specimen, from the Aymestry limestone, Aymestry. |
| 5, 5 <i>a</i> , 6. | " " | Two small specimens. Aymestry limestone, Mocktree. |
| 7, 7 <i>a</i> . | " " | A young shell, found by Dr. Holl in the Wenlock limestone of Benthall Edge. |
| 8. | " " | A specimen seen from the beaks. ('Sil. Syst.,' pl. vi, fig. 8.) |
| 9. | " " | Profile view of the interior of both valves. S, septum of ventral valve; V, dental plates; <i>x</i> , V-shaped chamber; <i>m</i> and <i>n</i> , septa in dorsal valve; O, hinge-plate. |
| 10. | " " | Transverse section. The same letters refer to the same parts. |
| 11—14 <i>a</i> . | " <i>linguifer</i> , Sow. | Different ages and modifications in shape. Wenlock limestone, Dudley, and Rushall Canal, Walsall. |
| 14 <i>b</i> . | " " | Interior of both valves seen in profile. |



PLATE XVIII.

SILURIAN SPECIES.

FIG.

- | | | |
|---------|-----------------------------------|---|
| 1—3. | <i>Pentamerus oblongus</i> , Sow. | After Sowerby's original figures ('Sil. Syst.,' pl. xix, fig. 10). Upper Llandovery; Shropshire and Llandovery. |
| 4, 4 a. | " " | Upper Llandovery; Hope Quarry, N.E. of Chirbury. Mus. Geol. Survey of London. |
| 5. | " " | Internal cast of ventral valve, showing the median septum. Upper Llandovery, Norbury. Mus. Geol. Surv. |
| 6—6 b. | " " | Internal cast. Upper Llandovery; Nash Scar, Presteign. Mus. Geol. Surv. |
| 7. | " " | Internal cast of ventral valve. Upper Llandovery; the Hollies, Wrekin. Mus. Geol. Surv. |
| 8. | " " | Ventral valve. Boocaun, Cong, County Galway, Ireland. Sir R. Griffith's Collection. This is the specimen referred to by Prof. M'Coy in his 'Synopsis Sil. Foss., Ireland,' p. 38. |
| 9. | " " | Internal cast, seen from the beaks, and showing the position of the septa and converging dental plates in both valves. Upper Llandovery; Craig-yr-Wyddon. Mus. Geol. Surv., London. |
| 10. | " " | Small specimen. Llandovery rock; Ardmillan, Ayrshire. Mr. D. J. Brown's Collection. |
| 11. | " " | Longitudinal section, showing the septa and dental plates. Cappacorcogue, Cong, County Galway. Sir R. Griffith's Collection. |
| 12. | " " | (<i>P. lævis</i> , Sow.). A fragment ('Sil. Syst.,' pl. xix, fig. 9). Upper Llandovery; Shropshire. |

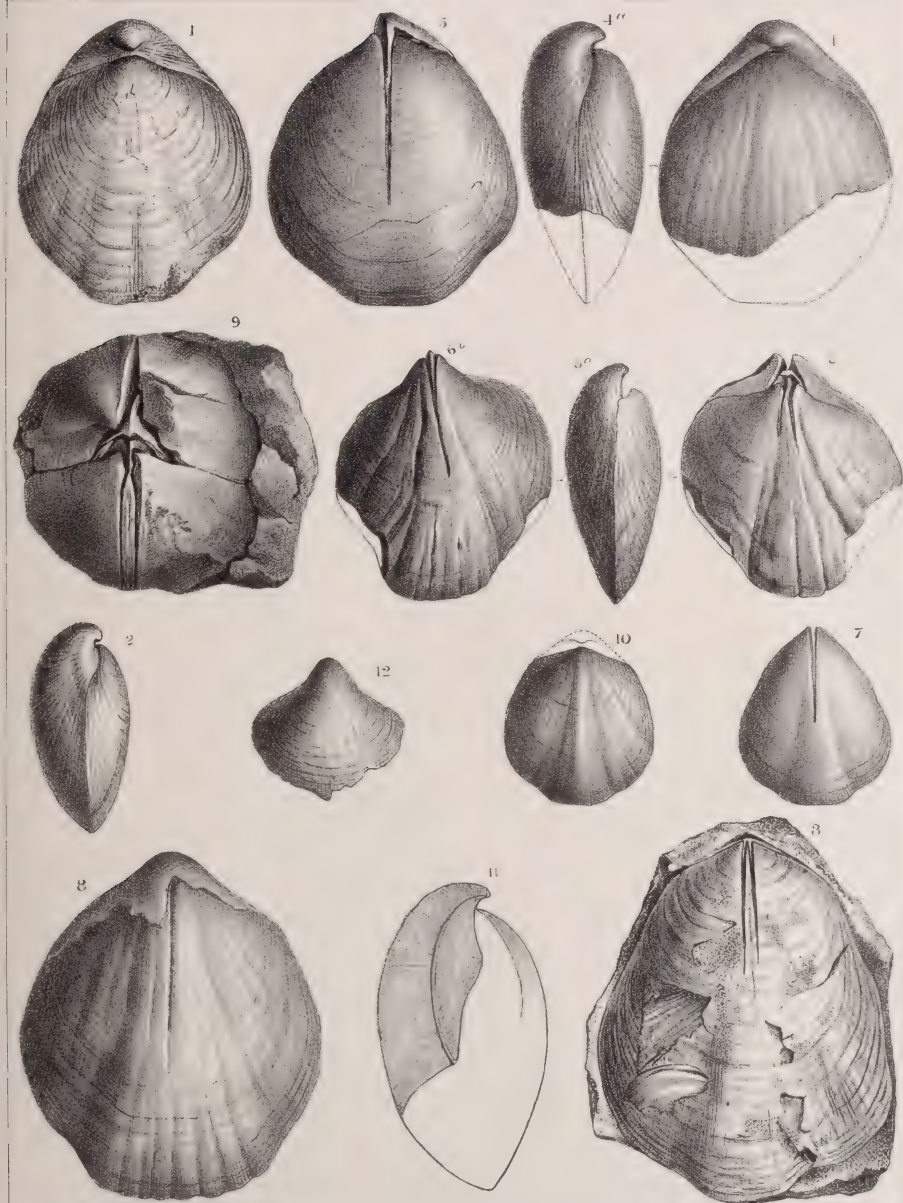
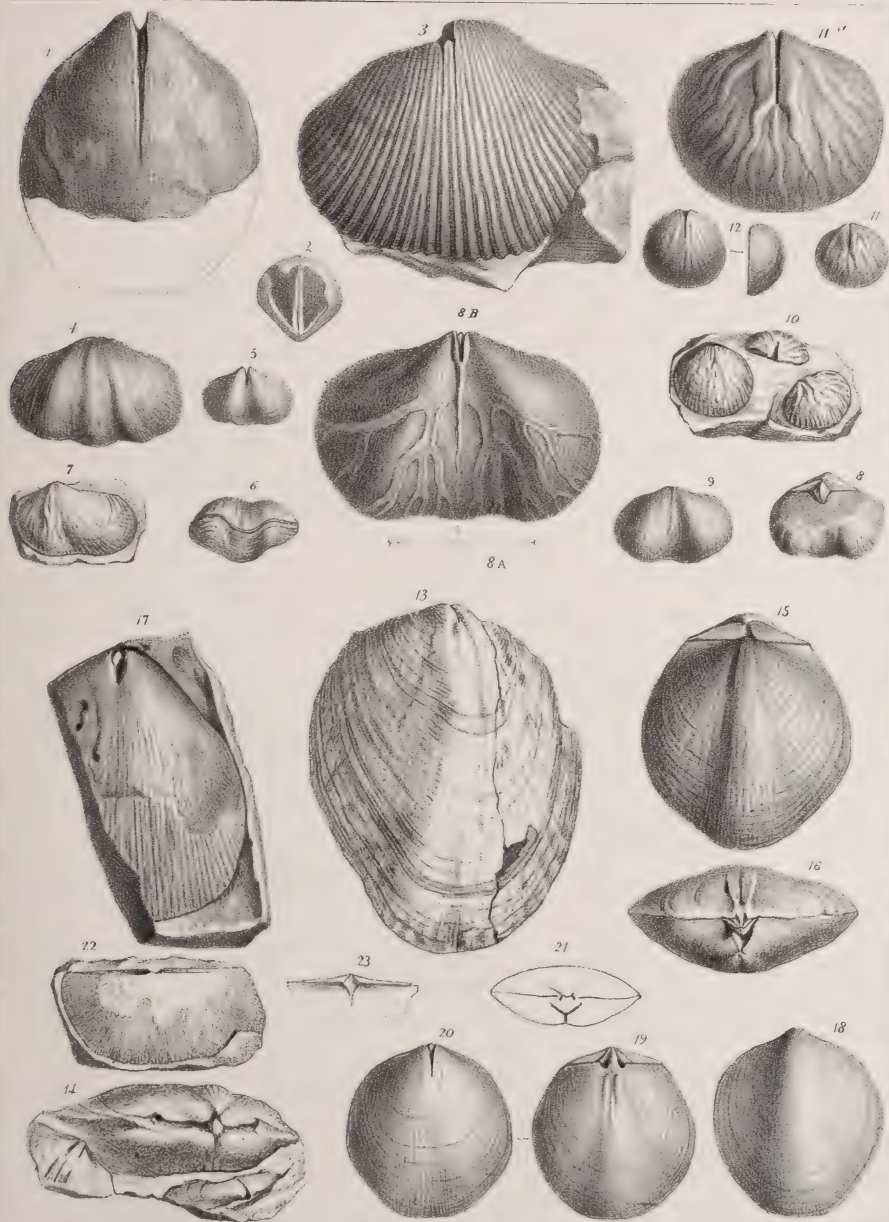


PLATE XIX.

SILURIAN SPECIES.

FIG.

1. *Pentamerus oblongus*, Sow. Cast of ventral valve. Llandovery rock; Penwhapple Glen, Ayrshire. Mr. D. J. Brown's Collection.
2. " " After original figure of *P. levis*, Sow. (young of *P. oblongus*). 'Min. Con.,' pl. xxviii, fig. 2.
3. " *Knightii*, Sow. Portion of a dorsal valve from Ballyaglish, east of Ferriter's Cove, Dingle, County Kerry. Sir R. Griffith's Collection.
- 4—9. " *undatus*, Sow. 4. Internal cast of ventral valve from Cefn-y-Garreg. Mus. Geol. Soc. 5. Internal cast of ventral valve. Lower Llandovery; Llandovery. Mus. Geol. Soc. 6. A bivalve specimen, viewed from the front. Lower Llandovery; Cefn Rhyddan. 7. Cast of ventral valve. Figs. 4 and 6, after the original examples figured in pl. xxi of the 'Silurian System.' Mus. Geol. Soc. 8. Cast, fractured so as to show the small converging dental plates of ventral valve. Noedd-Grug. Mus. Geol. Soc. 8A, 8B. Internal cast of a ventral valve, showing the vascular impressions. Lower Llandovery; Mathyrafal, Montgomeryshire. Mus. Geol. Soc. 9. Internal cast of ventral valve from Guilsfield, N. W. of Welshpool. Mus. Geol. Soc.
- 10—12. " *globosus*, Sow. Fig. 10. After the original figure in 'Sil. Syst.,' pl. xxii, fig. 2a. Lower Llandovery; Gorthoyr Fach, Llandovery. Mus. Geol. Soc. Fig. 11. Another specimen, nat. size. 11a. Enlarged; from Lower Llandovery; Castell-Craig-Gwyddon. Mus. Geol. Soc. 12. Internal cast; from Golden Grove, near Llandeilo.
- 13—21. *Stricklandinia lens*, Sow., sp. Figs. 13, 14. After the original figures in 'Sil. Syst.,' pl. xxi, fig. 13; from the Upper Llandovery; Norbury. Mus. Geol. Soc. 15. Slightly restored figure, from a specimen obtained from the Lower Llandovery; North of Gorrllwynfawr. Mus. Geol. Soc. 16. Internal cast, viewed from the beaks. Upper Llandovery; Craig-yr-Wyddon. Mus. Geol. Soc. 17. Portion of the internal cast of ventral valve. Llandovery; Woodford Green, near Tortworth. Mus. Geol. Soc. 18. Ventral valve. Upper Llandovery; Norbury, Bishop's Castle. Mus. Geol. Soc. 19, 20. Internal cast. Upper Llandovery; Avening Green, near Tortworth. Mus. Geol. Soc. 21. Transverse section, quite close to the hinge.
- 22, 23. " " (*Pentamerus microcamerus*, M'Coy.). 22. A fragment, after the drawing in 'Silurian System,' pl. xxi, fig. 12. Llandovery; Lickey, Staffordshire. 23. After the woodcut at p. 210 of M'Coy's 'British Pal. Fossils,' stated to be the internal cast of rostral part of ventral valve, showing the cardinal area and small rostral chamber formed by the converging of the dental lamellæ.



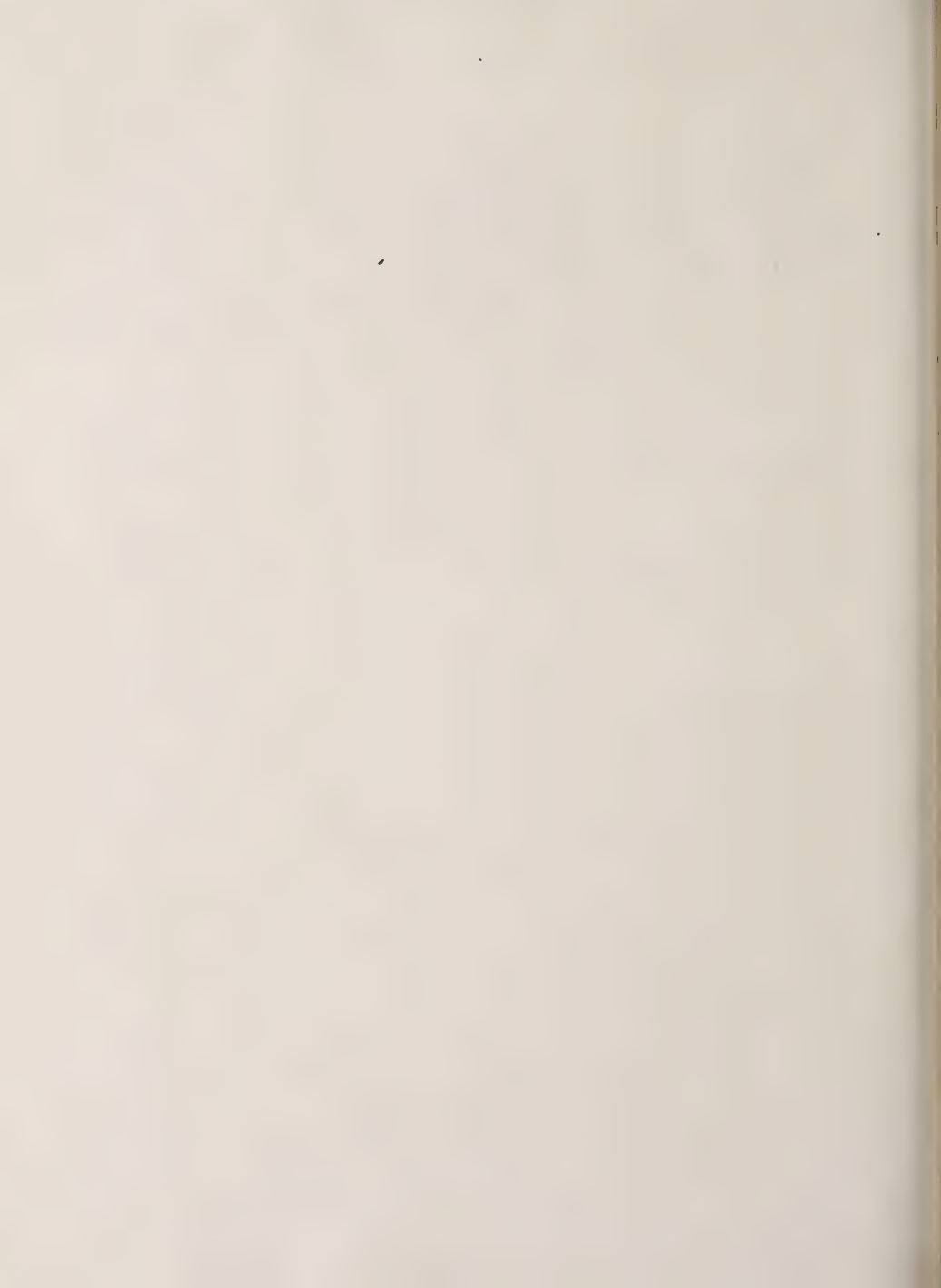


PLATE XX.

SILURIAN SPECIES.

FIG.

- 1—2. *Stricklandinia lirata*, Sow. sp. Upper Llandovery; Howler's Heath, Malvern Hills. 1 A, internal cast of dorsal valve. 1 B and 2, internal casts of ventral valve. Dr. Holl's Collection.
3. „ „ 3 A. Internal cast of dorsal valve; 3 B, of ventral valve. Howler's Heath. Mus. Geol. Soc.
- 4, 5, 6. „ „ Internal casts. Upper Llandovery; May Hill.
7. „ „ A dorsal valve of very transverse shape. Woolhope limestone; Woolhope. Mus. Geol. Surv.
8. „ „ (*Spirifer ovatus*, M'Coy.) Drawn from the specimen of which Prof. M'Coy gives a reduced figure in his 'Synop. Sil. Foss. of Ireland,' pl. iii, fig. 24. From Egool, Ballaghadorreen, County Mayo. Sir R. Griffith's Collection.
9. „ „ Interior of ventral valve; and
10. „ „ Interior of dorsal valve. These figures have been drawn from gutta-percha moulds, made from internal casts found at Howler's Heath.
11. „ „ Portion of a beautifully preserved internal cast of dorsal valve from Howler's Heath. Mus. Geol. Surv.
12. „ „ Horizontal section, close to the hinge.
13. „ „ An internal cast of a small, exceptionally shaped or malformed specimen. From Upper Llandovery; Nash Scar. Mus. Geol. Surv.

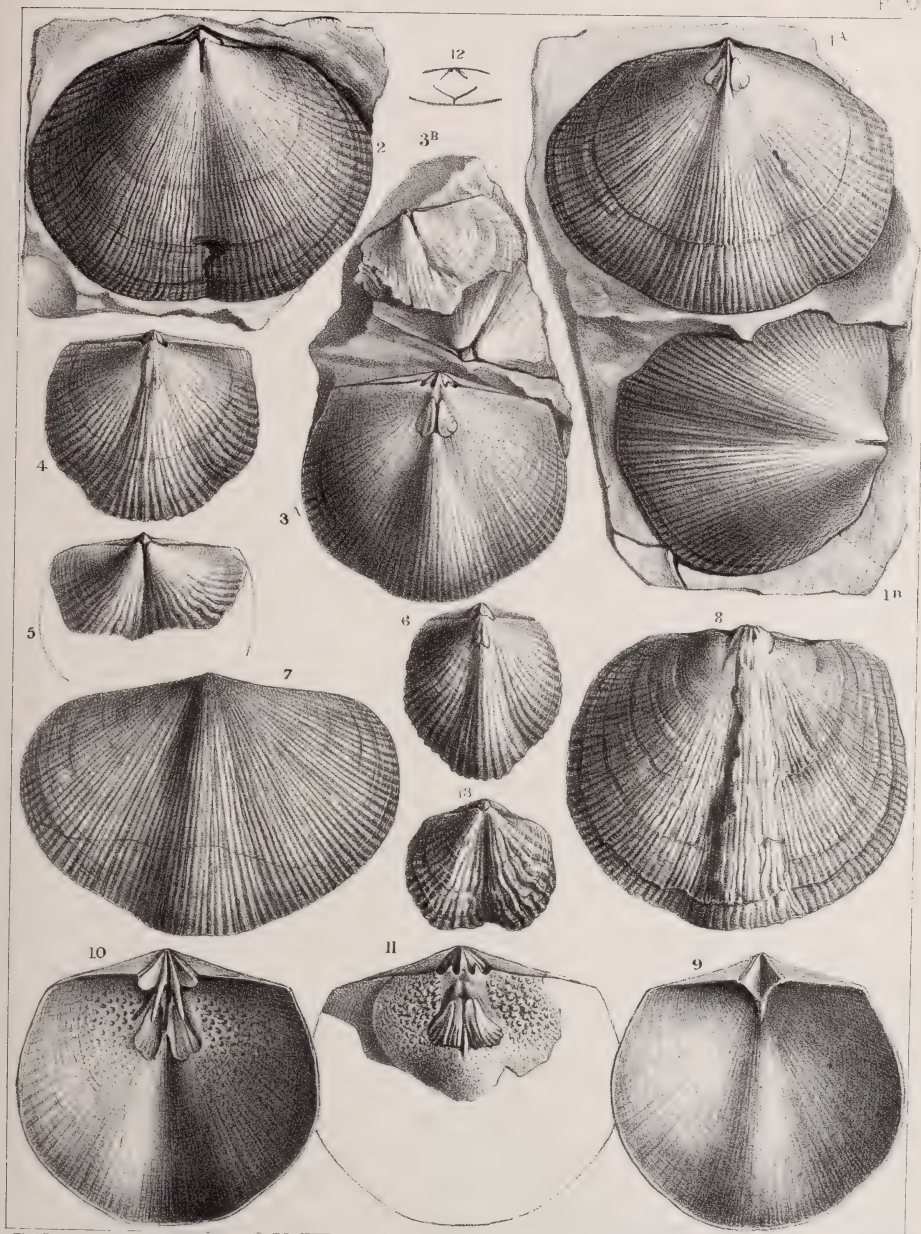


PLATE XXI.

SILURIAN SPECIES.

FIG.

- 1—6. *Rhynchonella Stricklandi*, Sow. 1, 1 *a*. After the original figure, 'Sil. Syst.,' pl. xiii, fig. 19. Wenlock limestone; Longhope. Mus. Geol. Soc. 2—2 *b*. A large specimen from Wenlock shale; Gaer-y-coed, Usk. Mus. Geol. Survey. 3, 4, 5. Three specimens from Wenlock limestone, Malvern. 6. A very fine internal cast of ventral valve, enlarged; showing the muscular and vascular impressions. (The ribs have not been marked, in order to show the vascular markings the better.) Wenlock limestone; Tucking Mill, Usk. Mus. Geol. Survey.
- 7—11 *c*, and 12 ? *Rhynchonella cuneata*, Dalman. 7, 8, 9. Different specimens from the Wenlock limestone of Dudley. 10 *a*. Beak enlarged, to show foramen and deltidium. 11. A young example; *a*, *b*, *c*, enlarged. 11 *c*. Beak very much magnified, to show the foramen and deltidium. 12. A cast which has been referred to *Rh. cuneata*, from Mulloch Hill, Ayrshire; but this identification is uncertain.
13. *Rhynchonella sexcostata*, M'Coy. After the original figure in the 'Synops. Sil. Foss. Ireland,' pl. iii, fig. 30. Lettershambally, Leenane, County Galway. Sir R. Griffith's Museum. The value of this species is uncertain, no complete example having been found; and it is here given simply for sake of reference.
- 14—20. „ „ *borealis*, Schloth. Figs. 14, 15, and 18. Three large typical specimens from the Wenlock limestone; Longhope. Mus. Geol. Survey. 16, 17. Two varieties from Dudley. 19, 20. A variety with a large number of smaller ribs, termed *Terebratula lacunosa* in 'Silurian System,' pl. xii, fig. 10. Wenlock Edge.
- 21—23. „ „ „ var. *diodonta*, Dal. Fig. 21, copied from Sowerby's figures of *Terebratula bidentata*, 'Sil. Syst.,' pl. xii, fig. 13 *a*; and 'Siluria,' 2nd ed., pl. xxii, fig. 5, where it is designated *Rhynchonella borealis*, var. *diodonta*. Wenlock limestone; Dudley. 22. Also from Dudley. 23. A small specimen from the Wenlock limestone of Falfield, showing the scaly concentric ridges described by d'Eichwald.
- 24—27. „ „ „ Variety. Fig. 24, from Wenlock Edge. Mus. Geol. Survey. 25—27. From Dudley; showing how variable is the number of the ribs on the fold and in the sinus.
28. „ „ *Stricklandi* (*Terebratula crispata*, Sow.). After the original figure, 'Sil. Syst.,' pl. xii, fig. 11. Mus. Geol. Soc.

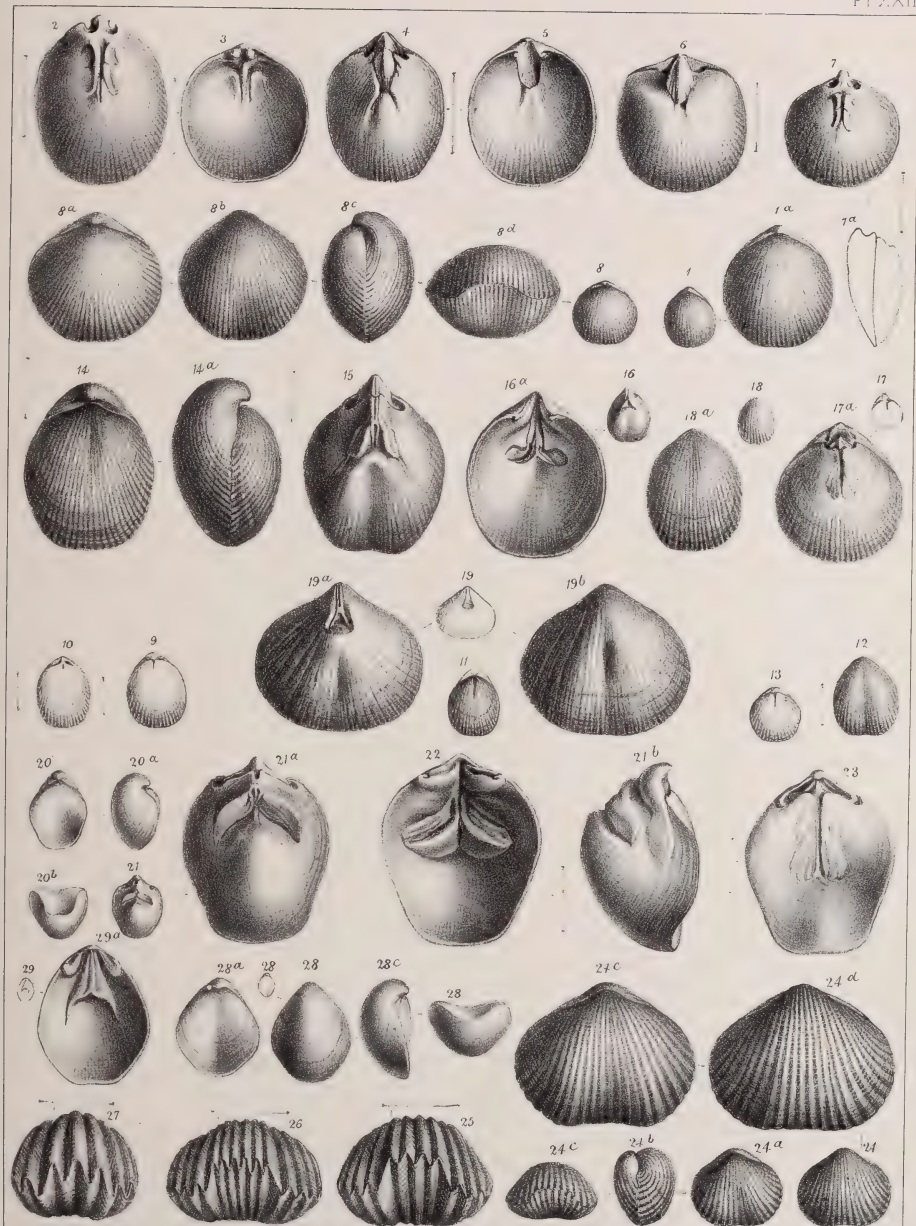


PLATE XXII.

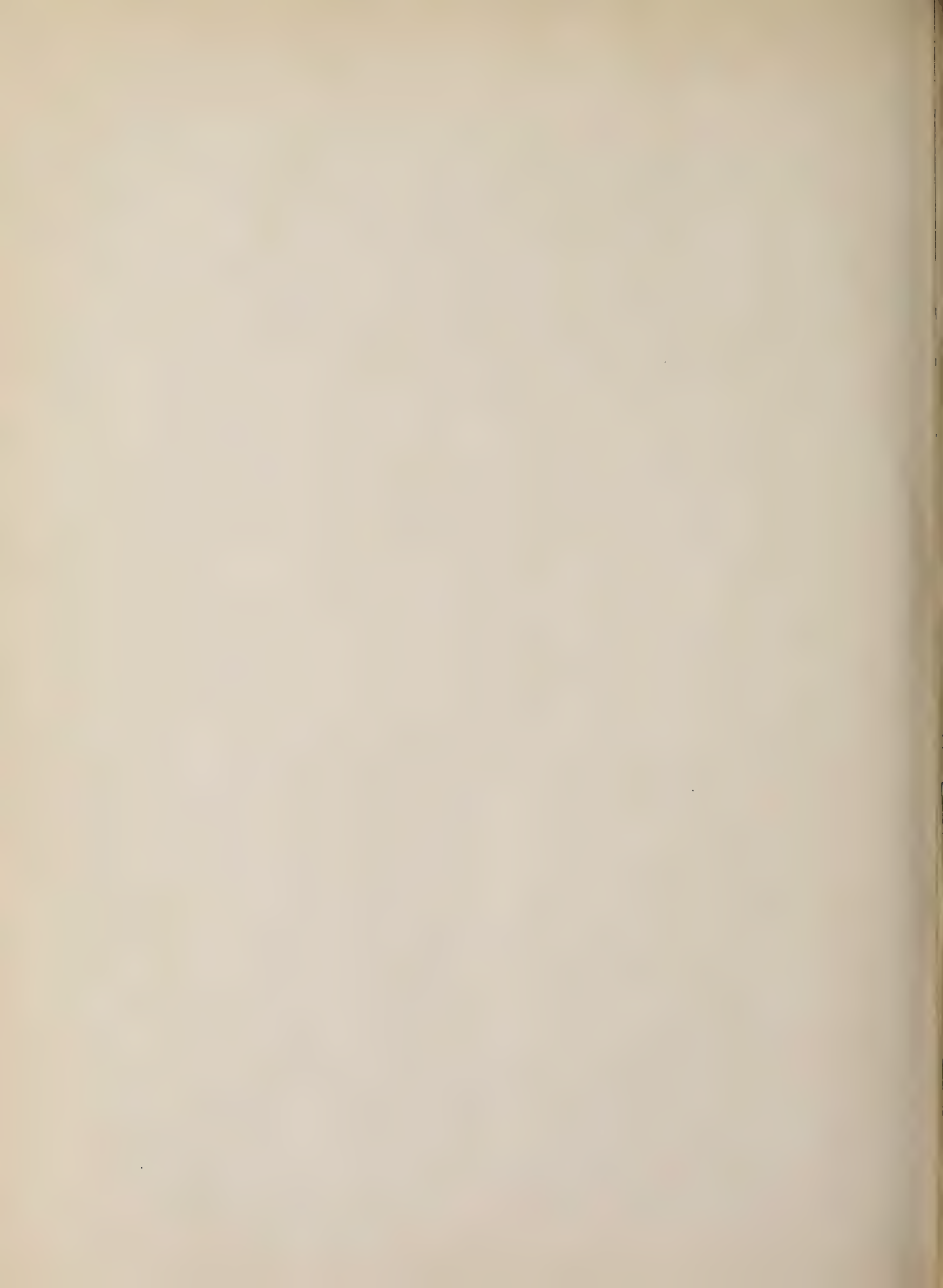
SILURIAN SPECIES.

FIG.

- 1—7 *a. Atrypa? Headii*, Billings (?), var. *Anglica*. [Genus uncertain.] Caradoc; Grangegeeth, County Meath. Fig. 1. Nat. size; all the others enlarged. 2 and 7. Internal casts of dorsal valve. 3. A gutta-percha mould taken from cast, and showing the interior of dorsal valve. 4 and 6. Internals casts of ventral valve. 5. A gutta-percha mould taken from an internal cast of ventral valve. All in the Mus. Geol. Survey, Ireland. (Mr. Billings informs me that the internal spires in *A. Headii* are arranged as in *Atrypa*.)
- 8—8 *d.* „ „ From the Caradoc of Moelydd, Shropshire, on the borders of Denbighshire. Mr. D. C. Davies' Collection, 8. Nat. size. 8 *a*—*d*. Enlarged.
- 9—19 *b. Rhynchonella? Pentlandica*, Haswell. Ludlow Rock; Deerhope Burn, Pentland Hills. 9, 10. After Salter's original figures in the "Explan. Sheet 32, Scotland," 'Mem. Geol. Survey,' p. 138, pl. ii, figs. 7 and 7 *a*. Figs. 11—18 *a*. A series of illustrations showing the external and internal characters; most of the figures being enlarged. 19. A transverse variety (a cast); from Mr. Haswell's Collection. 19 *a*. Internal cast enlarged; 19 *b*, exterior, enlarged from fossil impression.
- 20—23. „ ? *navicula*, Sow. 20—20 *b*. A bivalve example, nat. size, from the Aymestry limestone; Sedgley, near Wolverhampton. 21. Internal cast of ventral valve, nat. size. 21 *a*, *b*. The same magnified. 22. A mould in gutta percha, from an internal cast of ventral valve. 23. Internal cast of dorsal valve. These casts are from the Upper Ludlow; Coppice Ludlow. Mrs. Branwell's Collection.
- 24—27. „ *deflexa*, Sow. 24—24 *c*. Nat. size. 24 *c* (bis), *d*. Enlarged. Wenlock limestone; Dudley. Figs. 25—27. Three specimens enlarged, and viewed from the front, to show how variable is the number of ribs on the fold and in the sinus in different examples. All from Wenlock limestone; Dudley.
- 28, 29. *Merista* or *Camarium* (?) *cymbula*, Dav. [Genus very uncertain.] Fig. 28 (small figure), nat. size; others all enlarged. 29. Internal cast of ventral valve, nat. size. 29 *a*. Enlarged gutta-percha mould taken from the same cast. Caradoc; Hendre-Wen, Cerrig-y-Druidion. Mus. Geol. Survey.







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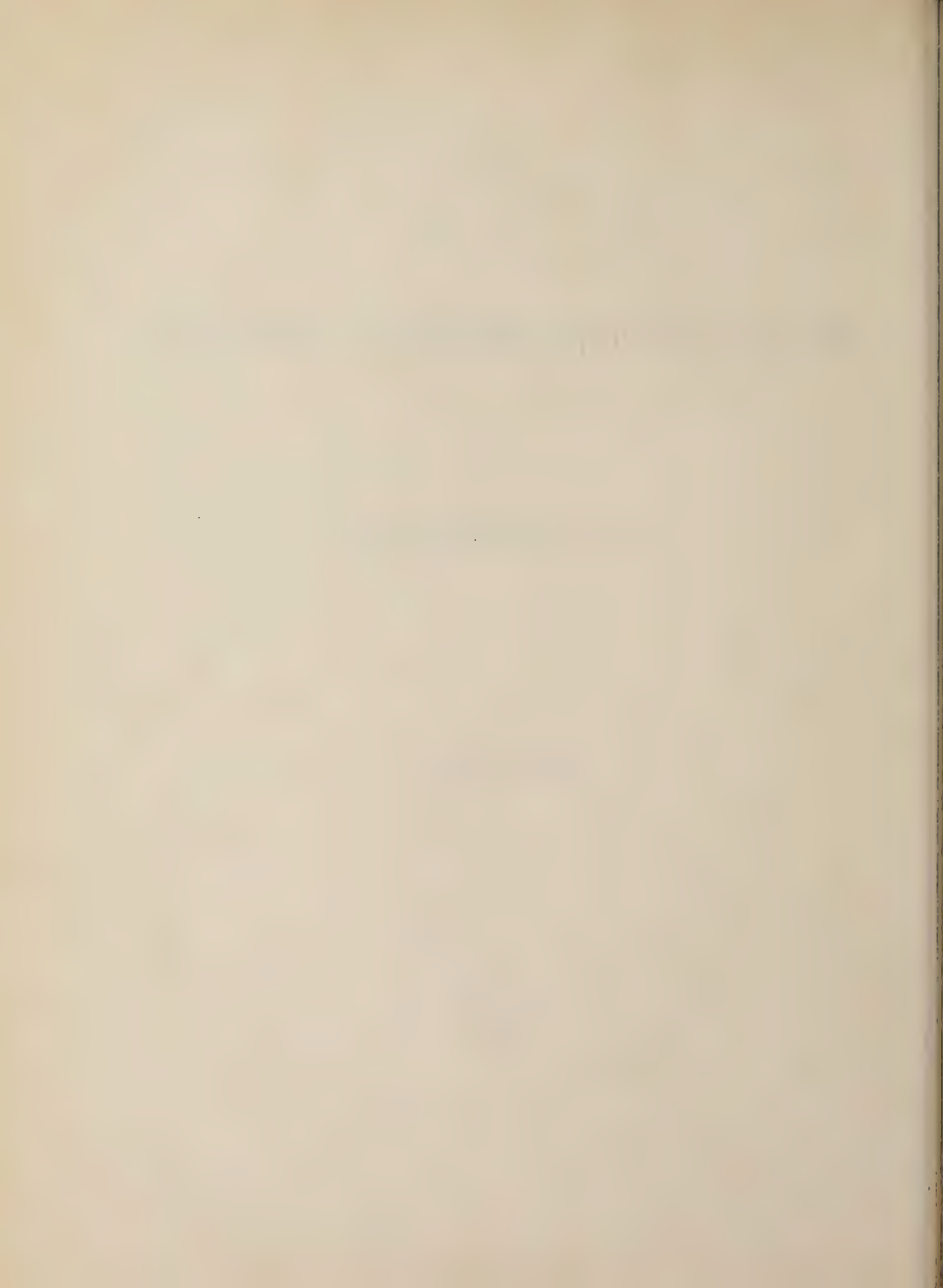
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A MONOGRAPH

OF

BRITISH BELEMNITIDÆ.

BY

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PART III,

CONTAINING

PAGES 53—88; PLATES VIII—XX.

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BELEMNITES BUCKLANDI, n. s. Pl. VIII, fig. 18.

Reference. *Belemnites ovalis*, Buckland, 'Bridgew. Treatise,' vol. ii, p. 69, pl. xlv', figs. 7, 8, 1836; and 'Bridgew. Treatise,' vol. ii, p. 71, pl. lxi, figs. 7, 8, 1858.

GUARD. Slender, smooth, subhastate by reason of a gentle swelling toward the end, which is convexo-conical and somewhat obtuse, the sides meeting at an angle of about 45°, with scarcely a trace of striæ or grooves.

Transverse sections are nearly circular, and show the axial line nearer to the ventral side, which in some specimens is slightly but distinctly flattened.

Greatest length observed 5.15 inches, of which the axis of the guard occupies 2.00; the chambered part of the phragmocone appears to occupy the remaining portion of the length (3.15 inches). The greatest diameter below the apex of the alveolar cavity 0.50 inch.

Proportions. The ventro-dorsal diameter at the alveolar apex being 100, the transverse diameter is 96, the ventral radius about 43, the dorsal radius about 57; axis, 480 in young, 300 in old.

PHRAGMOCONE. Insufficiently known from Dr. Buckland's figure, which represents it with nearly straight sides meeting at an angle of 28°, and septal intervals about 1/10th of their diameter—an ordinary proportion.

Localities. Golden Cap, Lyme Regis, from the Belemnite-bed (*Miss Anning, Phillips*). The first specimen figured by Dr. Buckland was in the collection of Miss Philpotts. In Upper Lias (sandy part), Blue Wick (*Phillips*). It has not occurred to me in the Midland Lias, nor do I find it in the large series of Belemnites from the vicinity of Banbury belonging to Mr. Stuttard.

This species has no slight analogy to *Belemnites ventro-planus* of Voltz ('Obs. sur les Bélem.,' pl. i, fig. 10), and to *B. umbilicatus* of Blainville ('Mém. sur les Bélem.,' pl. xi, fig. 11). Possibly they are all one species; for the umbilication of the end and the ventral flattening toward the end are not constant characters, and are not absent from some English specimens of *B. Bucklandi* which I have examined.

Observations. The opinion of Dr. Buckland, that the extinct Belemnites and the living Sepiadæ agreed in possessing an ink-bag, was corroborated by the discovery of the specimen figured in his 'Bridgewater Treatise,' and copied fig. 18, Pl. VIII of this Essay. The collection of Miss Philpotts contained this, at that time, "unique specimen," which presents, in a somewhat indistinct roundish mass, what remains of the ink-bag in the anterior part of the phragmocone. "A fracture at *δ*' shows the chambered areolæ of the alveolus. At *e* the thin, conical, anterior, horny sheath originates in the edge of the calcareous sheath, and extends to *e*". The surface of this anterior sheath exhibits wavy transverse lines of growth; it is much decomposed, slightly nacreous,

and flattened by pressure. Within this anterior conical sheath the ink-bag is seen at *e*, somewhat decomposed, and partially altered to a dark gray colour." ('Bridgewater Treatise,' vol. ii, p. 69, Ed. 1; and vol. ii, p. 71, Ed. 2.) The treatise just referred to contains several good representations of ink-bags, supposed to be of the "*Belemnosepia*," which may have belonged to this species. The fine, almost complete, fossil animal figured by Prof. Huxley ('Mem. Geol. Surv.,' Monogr. II, pl. i, fig. 1) is not dissimilar to the specimen in Miss Philpotts' Collection, in all the sheath and phragmocone, but it is believed to belong to a different species.

The name assigned to this species in the 'Bridgewater Treatise' by Dr. Buckland, having been already employed by Blainville for a very different form, cannot be retained. Neither "*B. umbilicatus*" nor "*B. ventro-planus*" appears very suitable or of determinate application, so that, perhaps, the exigencies of the case may be best met by a new name, in honour of a great and early palæontologist.

BELEMNITES MILLERI, n. s. Pl. VIII, fig. 19.

GUARD. Slender, elongate, cylindroidal below the alveolar region, evenly tapering to a convexo-conical or acute summit, with none or only very faint traces of striæ or dorso-lateral grooves; section nearly circular, with the axis more or less excentric.

VAR. *a*. Apex convexo-conical, without trace of grooves.

β. Apex more pointed, with traces of very short dorso-lateral grooves.

Greatest length observed, 4·5 inches, of which the axis of the guard is 2·75.

Proportion of axis to diameter at apex of phragmocone 450 to 100 in var. *a*; 750 to 100 in var. β.

PHRAGMOCONE. Only known by a longitudinal section, which exhibits septa more than usually approximate, and sides somewhat arched, uniting at an angle of 28°.

Localities. Golden Cap, near Lyme Regis, in Middle Lias; Blue Wick, Yorkshire, in Upper Lias (*Phillips*). Hatch, near Taunton, in upper part of Lower Lias, with *Ammonites obtusus*, *A. raricostatus*, and *Spirifer Walcotii* (*Moore*). Lower Lias shales, the Belemnite-bed, Cheltenham (*Buckman*).

Observations. To judge by the drawing given by Miller to represent his *Belemnites elongatus*, this might have been the species meant, without grooves or striæ. Mr. Sowerby's suggestion of the relationship of *B. clavatus* (*pistilliformis*, 'Min. Conch.') to *B. elongatus* might thus acquire more probability, but the sections which I have made do not show in the inner laminæ the very clavate form of the young which is required by the hypothesis. In Quenstedt's pl. xxix, fig. 51, we have a slightly hastate form much allied to this, the specimen having been derived from the "black Alpine limestone," locally associated with talc-schists, or coal-formation, and Upper Liassic shales, near

Grenoble. Similar, also, are some Belemnites discovered by Mr. C. Moore at Camerton, in the "Bucklandian beds" of Lower Lias, of which it seems proper to add the provisional description which follows; though, until further specimens come to hand, sufficient figures and sections cannot be given.

BELEMNITES GRANDÆVUS, n. s.

GUARD. Slender, cylindrical, gradually tapering to a produced (bent) point; no groove on any part, but the sides somewhat flattened with age; section nearly round in the young specimen, a little compressed when older.

Dimensions. Of the two specimens, one, the younger, is 3.125 inches long; the other, older, only 2.5, probably a deformed specimen.

Proportions. The longest diameter at the apex of the phragmocone being taken at 100, the ventral part of it is 43, the dorsal 57; the apical line 500 in the young specimen, but in the old specimen 300.

Locality. Lower Lias, "Bucklandian beds," Camerton, Somerset (*Moore*). The specimens are reddened by oxidation of iron.

Observations. Both specimens are bent towards the point a little irregularly, that is, obliquely to the general dorso-ventral plane of symmetry. The younger specimen has a produced striated apex; in the older one this part is contracted and irregularly plicated, with a sort of umbilicus. The surface is in parts eroded, so as to show the curiously undulated plications of the formative membrane. In early age the guard was depressed, when full grown compressed; these variations depend on the thicknesses of the successive increments by laminae of growth.

BELEMNITES POLLEX, *Simpson*. Pl. IX, fig. 20.

Reference. *Belemnites pollex*, *Simpson*, Yorkshire Lias, No. 18, p. 27, 1855.

GUARD. "Subcylindrical, short, one side rather flattened; apex very obtuse, with a short irregular groove." "Length $3\frac{1}{2}$ inches, width $1\frac{1}{4}$ inch."

Locality. Whitby, in Upper Lias, from the collection of the late Mr. Ripley (*Simpson*). West of Staithes, from the upper part of the Lower Lias (*Phillips*).

Observations. Of this remarkable form only two examples of the guard are known to me—the large specimen in the Whitby Museum, represented in my sketch, Pl. IX, fig. 20, which was described by *Simpson*; and the smaller one figured on the same plate, which is in my cabinet. *Simpson's* description is given above. The short irregular groove mentioned cannot be esteemed diagnostic. The diameter of the guard is almost imperceptibly enlarged behind the alveolar region. The axis of the guard does not much

exceed the diameter at the alveolar apex. I hope to receive more specimens, and to give sections hereafter.

BELEMNITES ACUMINATUS, *Simpson*. Pl. IX, figs. 21, 22.

Reference. *B. acuminatus*, *Simpson*, *Lias Fossils*, No. 29, p. 29, 1855.

B. ferreus, *Simpson*, *Lias Fossils*, No. 28, p. 29, 1855.

GUARD. "Cylindrical for nearly the whole length, then suddenly ends in a sharp point somewhat produced; transverse section circular; length of guard about five times the diameter." To this description of *B. acuminatus* *Simpson* adds the following note, which, perhaps, refers to a different species:—"A specimen like in form has two slight grooves and one strong groove at the apex." Of *B. ferreus* he only says, "Apex elongated; no groove; base widened."

Locality. *B. acuminatus*, Jet-rock, Upper Lias, Whitby (*Simpson*).

B. ferreus, Middle Lias (*Simpson*).

The specimens are in the Whitby Museum.

Observations. The sketches given in Pl. IX of the two forms here described show their great affinity and probable identity. I have had no opportunity of examining sections.

On account of general form and freedom from grooves or striæ, there seems reason to maintain for these Whitby specimens a distinct place and name. I have not yet perceived among the fossils of Lyme Regis, Cheltenham, or Banbury, any closely allied forms; nor did the rich collections of Strasburg and Paris suggest to me any decided analogue.

ON A GROUP OF ELONGATE BELEMNITES, WITH STRIATED APICES.

Among the frequent fossils in the scars at Saltwick, near Whitby, where the Upper Lias shales are largely exposed, is a beautiful group of slender elongated Belemnites. For the most part they exhibit but feeble traces of lateral or ventral furrows, but are more than usually striated at and near the apex. These forms are represented on Pl. X, which includes several species or varieties, as may be determined by further research. Figs. 23, 24, 25, 26, show forms in which the apical part is conoidal and deprived of distinct furrows; while in Fig. 27 the usual furrows appear, and the Belemnite is tripartite. All of them are acute; some have the apex very much drawn out; all are striated near the apex, and for some distance from it. All are somewhat compressed, some of them considerably. In the published figures of Belemnites none are so like to these as the representations of *Belemnites acuarius gracilis*, *Quenst.*, 'Céph.', pl. xxv, fig. 4, and *Belemnites tripartitus gracilis*, by the same author, pl. xxvi, fig. 17.

The fossils so depicted come from the Upper Lias; they have distinct ventral and dorso-lateral grooves.

Several of these Yorkshire forms have been described by Simpson (Lias Fossils, No. 9, 10, 11, 12, 16), but not figured.

In the cliffs of Dorsetshire, about Lyme Regis, Charmouth, and Seatown, a considerable number of Belemnites occur corresponding to these in length, general form, and compression; some are deficient of grooves near the apex, and others show them more or less; but striation about the apices, if not wholly absent, is not systematically present. The surface of the Dorsetshire Belemnites is not always perfectly preserved; it is often somewhat eroded. I have, however, succeeded in identifying a few specimens with one of the Yorkshire fossils. Besides this, the sides are usually channelled or marked by plane facets, so as to produce on the whole a different aspect to the eye. Some of these forms from the Dorsetshire Lias are given on Pl. XIII.

After examining as many specimens as I could extract from the Lias near Whitby, and others from Robin Hood's Bay, collected for me by Mr. Peter Cullen, I have thought it desirable to employ separate names for four forms which offer available characters, and perhaps further search may prove them to be really distinct; but it will be often very useful to employ for them all collectively the general term of "*graciles*." There is one allied form in the Lower Lias of Yorkshire.

BELEMNITES LEVIS, *Simpson*. Pl. X, figs. 23, 26.

Reference. *Belemnites levis*, Simpson, Lias Fossils, No. 9, p. 25, 1855.

Belemnites trivialis, Simpson, Lias Fossils, No. 11, p. 26.

GUARD. Compressed; elongate; tapering uniformly, and at last rather suddenly, to the apex, which is occasionally crested, plaited, or striated, without distinct grooves on any face. Sections show the contour to be elliptical, with a slightly excentric, nearly straight axis.

Dimensions. Greatest length observed of the guard alone 4 inches, beyond which the conotheca, converted into bisulphide of iron, is traced 1 inch.

Proportions. The diameter, *v* *d*, at the apex of the phragmocone, being taken at 100, the cross diameter is 88, the ventral radius 44, the dorsal 56, the axis 350 to 500.

PHRAGMOCONE. A little arched, ending in a spherule, with septa occupying a length equal to that of the axis of the guard.

Locality. Jet-rock of the Upper Lias, Whitby, rather plentiful (*Simpson*); also above the Jet-rock at Whitby and Robin Hood's Bay (*Phillips*). Specimens allied to

these occurred to me in Lower Lias (upper part) under Huntcliff, but they are very much more acute (see *B. elegans*).

Observations. Simpson makes no mention of the phragmocone or alveolus, but his notes on the guard are ample. They are as follows:

"*B. levis*. Length of guard about five times its width, slightly depressed, smooth, and regular; apex generally compressed, sometimes with a flattened process; the surface in places toward the smaller end firmly and distinctly corrugated like leather, probably by the impression of the mantle; general length 3 or 4 inches. Some have the apex striated."

"*B. trivialis*. Subconical, moderately stout, expanding at the base, with numerous fine striæ at the rather obtuse apex; general length 2 or 3 inches; smaller specimens approach the slender *B. subtennis*, larger ones the more robust *B. levis*."

The figures given in Pl. X, fig. 23, were sketched from specimens in the Whitby Museum; the others (fig. 26) are in my cabinet, collected from the Saltwick shore (1864). The striation is remarkable for distinctness and continuity over about a third of the post-alveolar space; but it can be traced further forward in short, discontinuous, wavy ridges.

BELEMNITES DORSALIS, n. s. Pl. X, fig. 24.

GUARD. Cylindroidal or slightly subhastate, tapering very gradually to a sharp apex; lateral grooves or flattenings on the middle and alveolar regions, not reaching to the apex; no ventral groove; a short definite dorsal groove on the alveolar region only.

Sections show the contour to be nearly circular, or a little compressed, or a little depressed; the axis excentric, even remarkably so in some examples. Greatest length, including expansion of the guard, $2\frac{3}{4}$ inches; greatest diameter behind the alveolar cavity, $\frac{1}{2}$ inch.

Proportions. The diameter, $v d$, at the alveolar apex being taken at 100, the radius v is from 30 to 40 (on an average about 35), and the radius d 60 to 70 (on an average 65); the axis about 700.

PHRAGMOCONE. Insufficiently seen for accurate description.

Locality. Saltwick, near Whitby, in Upper Lias (*Phillips*). Filey Cliffs, in drifted Lias (*Phillips*).

Observations. Thirteen specimens of different magnitudes, which I collected at Saltwick in 1864, furnish the grounds for the determination of this curious and rare form. I have seen it in no other collections, and have no knowledge of it beyond the small, probably young, specimens here figured. The little deep slit or canal on the dorsal aspect of the guard, is a circumstance unexampled in the Oolitic or Lias rocks. It appears only on the retral part of the alveolar cavity, and ends in most specimens quite

distinctly and definitely, both forward and backward. It is $\frac{1}{4}$ inch long. The lateral grooves or flattenings are variable in distinctness.

BELEMNITES STRIOLATUS, n. s. Pl. X, fig. 25.

GUARD. Compressed, elongate, tapering gradually to an attenuated, conical, finely striated apex; the striæ extend continuously over half the post-alveolar space, and in well-preserved specimens can be traced onward into minute, interrupted, undulated striæ, over nearly the whole surface. Where best seen (one third of the post alveolar space from the apex), there are about 100 striæ.

Sections across the guard behind the alveolus are elliptical, the axis but slightly excentric.

Dimensions. The largest observed is $3\frac{1}{2}$ inches long; of this length $\frac{3}{4}$ inch is crushed over the alveolus; greatest diameter (uncrushed) less than $\frac{1}{2}$ inch. The smallest specimen is less than 2 inches in length.

Proportions. Taking the diameter from back to front at the alveolar apex at 100, the cross diameter is 85, the ventral radius 45 or more, and the dorsal 55 or less; the axis is therefore but little excentric, and measures 500.

Locality. On the Upper Lias Scars at Saltwick, near Whitby, and in the same beds at Robin Hood's Bay (*Phillips*). A small number of specimens from the Belemnite-beds under Golden Cap are identified with this species (*Phillips*). A few small young examples, Glastonbury (*Moore*).

Observations. The affinity of this to the last-described species is obvious; and it is quite possible that further research may unite several of the forms here named separately into one species. But that will not render useless the nomenclature, if it expresses real and often observable peculiarities, for these are elements in the problem of the variation of life-form, in relation to time, space, and physical condition.

It is doubtful whether this species has been described. Simpson's description of *Belemnites substriatus* agrees, indeed; but the fossil is much larger than my specimens, an example in the Whitby Museum being $5\frac{1}{4}$ inches long.

"Similar in general form to *Bel. trisulcosus*, but with numerous striæ at the apex, and no grooves." (Lias Belemnites, No. 16.)

Belemnites subtenuis of Simpson contains, beside the trisulcose form which is characteristic, two others which are described as varieties, viz.—

Var. *a*. Grooves obsolete, apex not striated.

b. Thicker in proportion, apex not striated.

This want of striation is the only obstacle which seems to forbid the otherwise probable union of the varieties *a* and *b* to *B. striolatus*.

BELEMNITES SUBTENUIS, *Simpson*. Pl. X, fig. 27.

Reference. *Belemnites subtenuis*, Simpson, Lias Fossils, No. 12 (excl. α and β), p. 26, 1855.

GUARD. Very elongate, compressed, tapering uniformly to the apex, which is marked by three faint, though rather long furrows, and many fine striæ.

Sections show the outline to be elliptical, the axis very excentric and straight.

Dimensions. Largest specimen in my collection 4 inches long, the greatest diameter (uncrushed) less than $\frac{1}{2}$ an inch.

Proportions. The diameter, $v d$, at the apex of the phragmocone being taken at 100, the ventral radius is 36—38, the dorsal 62—64, the axis 700 to 1000, the diameter from side to side 76. Nearer the apex the diameters are less unequal.

PHRAGMOCONE. Visible, but not distinctly observable in the expanding anterior region. The flanges of the septa appear very short; the cross section is elliptical, but not so much as the section of the guard, which is thinner on the sides than on the dorsal or ventral face.

Locality. Above the Jet rock in Upper Lias at Whitby, abundant (*Simpson, Phillips*). Robin Hood's Bay, in Upper Lias (*Cullen*).

Observations. Simpson's description of *B. subtenuis* is in the following words:—"Slender, regularly tapering, with three long shallow grooves toward the finely striated apex." He allows two varieties from the type, viz.:—

Var. *a.* Grooves obsolete, apex not striated.

b. Thicker in proportion, apex not striated.

These may probably be better referred to *B. striolatus* (see p. 59). The group thus becomes definite, and may be compared with Simpson's larger but similar straight tripartite forms, viz., *B. trisulcosus* and *B. incisus*, which, it appears possible, may be full-grown individuals of the same species (see also p. 62).

ON BELEMNITES ALLIED TO BELEMNITES TRIPARTITUS OF SCHLOTHEIM.

Under the name "*Belemnites tripartitus*" foreign palæontologists have assembled a considerable variety of forms, some distinction among them being made after the manner of Quenstedt, who, in his 'Cephalopoda,' employs as *general terms* such titles as *tripartitus*, *paxillosus*, *compressus*, *brevis*, *digitalis*; and qualifies them by addition of other terms, as in *B. tripartitus sulcosus*, or by joining together even general terms, as *digitalis tripartitus*, *tripartitus paxillosus*, and the like. By this mode of proceeding the idea of real specific diversity is obscured, and that of a vague mixture of characters is introduced. Yet it has some considerable advantages for a serious inductive study of a large Belemnitic series, and will be referred to again. Others, as D'Orbigny, plainly join into one specific group a large number of "tripartite" forms which seem, at first view, to claim separation. Thus, under *B. elongatus* this author enumerates *B. aduncatus*, Miller, *B. trisulcatus*, Hartmann, *B. oxyconus*, Hehl, *B. incurvatus*, Zieten, and *B. propinquus*, Münster. And in his plate viii, figs. 6—11, the species is called *B. tripartitus*, Schl., though that name is omitted in the text ('Terr. Jurass.,' p. 90). Voltz gives as a different species *B. trifidus* ('Obs. sur les Bélem.,' pl. vii, fig. 3); and Blainville had already suggested for separation his *B. trisulcatus* ('Mém. sur les Bélem.,' pl. v, fig. 13).

On the Liassic coast of Dorsetshire these forms are so rare that I can hardly quote one from personal research. One is referred to by Quenstedt as from Lyme Regis, with distinct ventral groove, under the title of *B. digitalis tripartitus*, and figured pl. xxvi, fig. 31, of his 'Cephalopoda.' He remarks that it is exactly like German (*i. e.* Wurtemberg) examples. The Yorkshire coast produces a greater number and a greater variety of such forms.

There appear to be two principal sections of them, which in mature age may be thus separated:

Elongate, straight, three-grooved, often striated, as *B. tripartitus* and *B. subtenius* of these pages.

Shorter, somewhat recurved at the apex, with three rather short grooves, and few or no striæ, as *B. subaduncatus* and *B. vulgaris*, to be noticed hereafter.

In Mr. Simpson's work on the Lias of Yorkshire the "tripartite" forms are employed to constitute a larger number of species than appear to me necessary; but though I have had the opportunity of inspecting the fine collection at Whitby, which is the basis of his work, I do not find in it a sufficient *series* of forms, from youth to age, of the supposed species, to give more than a few indications of the synonymy which may guide further research.

BELEMNITES TRIPARTITUS, *Schlotheim*. Pl. XI, fig. 28.

Reference. *Belemnites tripartitus*, Schlotheim, 'Petref. Belem.,' No. 6, p. 48, 1820.

B. elongatus, D'Orbigny, 'Pal. Franç. Terr. Jur.,' p. 90, pl. viii, fig. 11, 1842.

B. digitalis tripartitus, Quenst., 'Ceph.,' p. 419, pl. xxvi, figs. 14, 31, 1849.

B. trisulcosus, Simpson, 'Lias Fossils,' No. 14, p. 26, 1855. (Section ovate.)

B. incisus, Simpson, 'Lias Fossils,' No. 15, p. 27, 1855. (Section nearly circular.)

GUARD. Straight, elongate, cylindroidal; sides more or less flattened, tapering in a continuous curve in the post-alveolar region to a three-grooved apex, which is distinctly striated on the dorsal aspect for half the length of the axis of the guard; grooves deepening toward the apex.

Sections show the contour to be oval, with the sides rather flattened, the dorsal part rather broadest, except toward the apex, where the contrary happens; the axis excentric and straight.

Greatest length observed (behind the expansion of the alveolar cavity), 6½ inches; greatest total length, 9 inches; greatest diameter, 1 inch.

Proportions. Taking the diameter, *v d*, at the apex of the phragmocone at 100, the ventral radius is 37, the dorsal 63, the cross diameter 88, and the axis 550 to 600.

PHRAGMOCONE. Not seen in my specimens. The section of the alveolus is very slightly oval.

Locality. In the Upper Lias of Saltwick (*Phillips*). In the Jet-rock, Saltwick (*Simpson*). In the Middle Lias of Banbury (*Stuttard*, No. 87).

Observations. In its young state this species is not certainly known, unless, as I think not improbable, *B. subtenuis* holds that place. Its very distinct, straight, narrow grooves, continued to the apex, distinguish it from the other triglyphic Belemnites of the Upper Lias of Yorkshire. Its nearest relative is a beautiful species which occurs in the Upper Lias of Ilminster and other localities of the South of England. Neither of those species has been found (as far as I have seen) at Lyme Regis. A specimen in my possession shows, on the dorsal aspect near the apex, a short, very narrow groove, which does not reach the apex (see Pl. XI, figs. 28 *d* and *s'*). In a younger specimen the striae are interrupted, as in fig. 28 *σ*.

BELEMNITES SUBADUNCATUS, Voltz. Pl. XI, fig. 29.

Reference. *Belemnites subaduncatus*, Voltz, 'Obs. sur les Bélemn.,' p. 48, pl. iii, fig. 2, 1830.

B. expansus, Simpson, 'Lias Belemnites,' No. 39, p. 46, 1855.

GUARD (Young). Cylindroidal, or subprismatic in the alveolar region, thence tapering in a lanceolate form (so as to be slightly or even distinctly subhastate) by a gentle curve to a very pointed prominent end, which bends a little toward the dorsal side. Three grooves part from near the ungrooved end, two of them dorso-lateral, becoming distinct at a short distance from the end, and gradually vanishing before reaching the alveolar apex; the third medio-ventral of variable length and distinctness, usually short, but perhaps never quite absent.¹

(Old.) Few examples are certainly known; in them the figure is more cylindroidal and more compressed, the termination is less acute and more recurved, so as to resemble, except in greater length, mature individuals of *B. vulgaris*, from which in youth they are quite distinct.

Longitudinal sections show the apical line to be somewhat curved, nearest the ventral face, and three, four, or five times as long as the diameter, according to age. Transverse sections in the young are subquadrangular across the alveolar region, somewhat oval behind it, and trilobed near the end; in the older specimens this section is decidedly oval. In all examples the axis is excentric, in the young remarkably so; the dorsal laminæ usually thickest over the alveolus, but the contrary also occurs.

Dimensions. The smallest specimen in my collection is 2 inches long (of which the axis is 1½), with a diameter of ¼. The sizes are traced with certainty to a diameter of ⅓ inch, with an axis of 1½. Other examples have a longer axis; but, on the whole, it appears, the proportions grow more robust with age. Voltz describes and figures specimens of intermediate magnitude only. I am uncertain as to the really old forms of the species; but I believe *B. distortus* of Simpson, No. 31 (Whitby Museum), to be a good example. On the whole, we may be sure of the identification of the young and middle-aged forms so common on the Whitby Scars, and so remarkable for their slender shape, very acutely pointed apex, slightly hastate figure (though this varies, and is sometimes only just traceable) by reason of a gentle swelling at about two thirds of the distance from the end toward the alveolar apex. The rather prismatic shape of the alveolar region caused Voltz to call it tetragonal, and sometimes the expression is correct.

¹ In my oldest specimen, ⅓ inch in diameter, it is hardly traceable.

Proportions. Taking the diameter from back to front at the alveolar apex at 100, the cross diameter is about 90, but this varies in different specimens; the excentricity of the axis is variable, in some young specimens the ventral is only 28 to the dorsal 72; in another specimen the ventral is 40, the dorsal 60; in another, ventral 48, dorsal 52; the axis is from 300 in middle-aged to 500 or 600 in the young. In Voltz's figure the axis is 340.

PHRAGMOCONE. Very slightly arched; its section oval, with proportions of 100 to 93; septa close, rather unequally arranged, but in the middle part, on the average, distant one seventh of the diameter, apparently formed of a single plate with a short flange. In a specimen from Whitby an extraordinary number of the septa are squeezed together in the hinder part of the last chamber, by pressure from without. If these were supposed to be the last septa, and to be replaced, the axis of the phragmocone would equal half the axis of the guard. The angle appears to be $24^{\circ}30'$ (Voltz gives 25°).

Locality. In the Upper Lias shale of Whitby and Saltwick (*Phillips*).

BELEMNITES ILMINSTRENSIS, n. s. Pl. XII, fig. 30.

GUARD. Elongate, straight, conoidal, more or less compressed, very gradually tapering over the whole of the guard to an acute point (24°), often cross-banded with light and dark shades; axis subcentral when young, more excentric when old; one ventral, two dorso-lateral furrows, all reaching the apex, the ventral furrow usually longest of the three. In young specimens the guard is depressed about the end, and shows a broad ventral furrow there, with slight and short traces of the dorso-laterals. The sides are often slightly canalicate for the whole length in young specimens.

Dorsal aspect rather broader than the ventral.

Sections show great excentricity of the axis in full-sized specimens, and in adults an oval section. In young specimens which are depressed, with flattened sides, the section of the guard is subquadrate.

Dimensions. Greatest length of axis of guard observed, 5 inches; greatest diameter of the most expanded part, 1 inch.

Proportions. Taking the dorso-ventral diameter at the alveolar apex at 100, the ventral radius is 33 +, the dorsal 66 +, the cross diameter 85; the axis in a very long compressed variety (axis 4.5 inches long) 800, in a shorter variety 600, in one still shorter 400, in the shortest 350. These are adults. In a young specimen the axis (1 inch long) is 350, in another (axis 0.6 inch long) 300, in the shortest of all the specimens (less than $\frac{1}{2}$ inch long) the proportion is nearly the same.

PHRAGMOCONE. Much extended under an angle at first of 24° , and afterwards of 18° .¹ Septa formed of one lamina, elliptical, with axis as 100 to 110, numerous (60 or more); depth of chamber, $\frac{15}{100}$ of the diameter; inner lateral surface of the chamber smooth and flat below the septa. Conotheca slightly undulated in rings, a little concave opposite each septum, a little convex between the septa. The septal outline is waved, and descends to the siphuncular border.

Greatest diameter observed, 1.6 inch; greatest length, 4 $\frac{1}{2}$ inches; in this case the axis of the guard is about 2 $\frac{1}{2}$ inch, and there are about 50 septa.

Locality. Ilminster, in Upper Lias, abundant, and of all ages (*Moore*). Dundry, full-grown, Upper Lias (*Bristol Museum*). Glastonbury (*Phillips*). Kimberley's Brick-yard and Workhouse Yard, Banbury, in Upper Lias, with *Ammonites communis* (*Stuttard*, No. 42, 44, 45). Upper Lias, Stroud (*Buckman*).

Observations. This elegant species is remarkable for the continual tapering through its whole length, by which it happens that no part of the guard is really cylindroidal. The angle of inclination of the sides of the phragmocone is very moderate (not exceeding 18° in the anterior part, but amounting to 24° in the hinder part); the section is elliptical.

In Mr. Moore's rich collection from Ilminster the growth of this species may be traced with great satisfaction from an individual less than half an inch long to full-grown examples of 6 and 8 inches from the apex of the guard to the last (or nearly the last) chamber. Two varieties also appear of unequal proportions, one being much more compressed, and with a longer guard. This is less common than the shorter variety. The degree of distinctness of the furrows also varies, so that we may mark different races; the longer ones, indeed, may be (according to D'Orbigny) males, the shorter ones females.

Var. *a.* All the three furrows of the guard distinct, the ventral one usually longest.

β. All the furrows indistinct.

And to each of these the variations of length may be added. Striations can hardly be traced about the apex, but occasionally appear in the ventral sulcus.

Taken as a whole, it appears that this fossil more than any other resembles in shape and proportions the original figure given by Miller for *B. elongatus*; but no specimen corresponding to that figure has been found in the Bristol collection. On the other hand, there are in that collection thick, tripartite Belemnites, with short axis of guard, referred to *B. elongatus* of Sowerby, from the Upper Lias at Dundry, with an alveolar angle of 25° .

¹ In one case this angle in the anterior part of the cone is found to be only $12^{\circ}30'$; in another large specimen, as much as 24° ; both exceptional instances.

BELEMNITES MICROSTYLUS, n. s. Pl. XIII, fig. 31.

GUARD. Very slender, almost perfectly cylindrical in the post-alveolar region till towards the apex, expanding over the conotheca with remarkable regularity. No lateral groove.

In young specimens the substance of the guard is transparent and solid toward the point, mostly opaque, and more friable in a long space over and behind the alveolar region, as in *B. clavatus*.

PHRAGMOCONE. Straight, very regularly tapering at an angle of 18° , with septa even or scarcely waved, and placed at distances somewhat greater than usual, viz., one fifth of the diameter.

Section of the phragmocone slightly elliptical.

Locality. One specimen, No. 349, in the Collection of the Geological Survey, Jermyn Street (fig. 31, c), was discovered by Mr. Day in a nodule from the Belemnite-bed of Lyme Regis. Another in the Oxford Museum (fig. 31, o) was presented by Mr. Murley from the Insect-bed at Dumbleton.

BELEMNITES LONGISSIMUS, Miller. Pl. XIII, fig. 32.

Reference. *Belemnites longissimus*, Miller, 'Geol. Trans.,' 2nd series, vol. ii, p. 60, pl. viii, figs. 1, 2 (Paper read April, 1823), 1826.

GUARD. Excessively elongate, compressed, with faint lateral grooves, and a blunt, roughly striated apex.

PHRAGMOCONE. Unknown.

Locality. Lyme Regis. In the Collection of the Bristol Institution is a specimen (No. 33) which may have served Miller in considering the species named *B. longissimus*. Another in the same collection (No. 27), marked *B. cylindricus*, Blainville, may be identical. I have a few examples from the Belemnite-bed under Golden Cliff, but none of these specimens are sufficient for good description. A Belemnite of the same general form, and even longer in proportion when young, occurs in shales of the Cromartie Coast, which have been called "Lias" by geologists. They, however, contain only fossils of the Oxford Clay and Coralline Oolite series, and the Belemnite has a different shape when old.

BELEMNITES JUNCUS, n. s. Pl. XIII, fig. 33.

GUARD. Excessively elongated, slender, nearly of equal diameter for a great length, expanded anteriorly, compressed, with shallow lateral risings and hollows extending along the whole length of the surface.

Sections of the sheath show the sparry lamellæ nearly circular toward the axis, but very elliptical toward the circumference. The apical line is nearly central. The fibres are coloured in light and dark bands. (The summit is unknown; the compression increases toward the summit.)

PHRAGMOcone. Unknown.

Dimensions. Total length of a fragment, above 3·5 inches; greatest diameter, 0·33; axis of guard, above 3·0.

Proportions of the guard, the diameter $a\ b$ at the apex of the alveolus being 100, the ventral radius is 48, dorsal radius $b\ 52$, cross diameter 75 to 85, axis of guard above 1500.

Locality. Golden Cliff, near Lyme Regis. The author possesses portions of two guards, including the alveolar and parts of the apical regions.

BELEMNITES NITIDUS, n. s. Pl. XIII, fig. 34.

GUARD. Remarkably elongated, compressed, for a great portion of its length of equal diameter, but acutely conical toward the summit, which is pointed; expanded anteriorly; smooth, with two very slight dorso-lateral grooves near the summit, and a double lateral furrow extending over nearly all the apical region.

Sections show the apical line nearly central, straight, surrounded by subelliptical lamellæ, finely fibrous, the outer ones acquiring double lateral flutings.

PHRAGMOcone. Unknown.

Dimensions. Total length, 7·5 inches (8·0); greatest diameter, 1·0; axis of guard, 5·5; alveolar axis, probably 2·5.

Proportions of the sheath, the diameter $a\ b$ at the apex of the alveolus being 100, the ventral radius is 46, dorsal radius 54, cross diameter 80, axis 1000.

Locality. Belemnite-bed, Golden Cliff, Lyme Regis (*Oxford Museum, Phillips's Cabinet*). Banbury, Lower Lias (*Stuttard*, No. 135).

BELEMNITES QUADRICALICULATUS, *Quenstedt*. Pl. XIII, fig. 35.

Reference. *Belemnites quadricaliculatus*, *Quenstedt's 'Jura,'* p. 285, pl. xli, fig. 17, 1857.

GUARD. Long conical, marked by four narrow grooves, from the apex to and extending over the alveolar region. One of the grooves is dorsal, and in very good specimens appears double (fig. 35 *d'*); it is deepest on the alveolar region; two are dorso-lateral, one is ventral. The apex is somewhat blunt, the grooves reaching to it. The surface unusually rough.

PHRAGMOcone. Unknown. Alveolar angle not measurable in either of the two specimens placed before the author by the Geological Survey.

Dimensions. Total length of specimen, 1.75 inch; greatest diameter, 0.33; axis of guard, 1.00 inch.

Proportions. The ventro-dorsal diameter at the alveolar apex being 100, the axis of the guard is 500, the cross diameter 96.

Locality. Upper Lias Sands at Chidcock (Museum of the Geological Survey in Jermyn Street, London). Upper Lias, Ilminster (*Moore*).

BELEMNITES TUBULARIS, *Young and Bird*. Pl. XIV, fig. 36.

Reference. *Belemnites tubularis*, *Young and Bird*, 'Geol. of Yorkshire Coast,' p. 259, pl. xiv, fig. 6, 1822; *Phillips's 'Geology of Yorkshire*, vol. i, p. 163, pl. xii, fig. 20, 1829.

B. acuarius, *Morris*, 'Catal.,' p. 300, 1854.

GUARD. Very elongate, slender, expanding over the alveolar region, uniformly tapering or cylindroidal in the post-alveolar region, greatly flattened in the apical region, ventral and dorso-lateral furrows on the flattened part. Surface striated unevenly, especially on the alveolar region. Proportion of the flattened part variable in different specimens. A slight hollow or flat space often runs down the sides of the guard. Strong parallel striae near the apex.

Transverse sections show an oval outline, with a nearly central axis in the young, a nearly circular outline in the older.

Dimensions. Greatest length observed (including only the beginning of the phragmocone), 10 inches; greatest diameter in the post-alveolar region, less than $\frac{1}{2}$ inch.

Proportions. Taking the diameter from back to front at the alveolar apex as 100, the ventral radius is 48, the dorsal 52, the cross diameter from 80 to 90, the axis of the guard about 1400.

PHRAGMOCONE. Incompletely observed; probably straight, with an angle of about 18° .

Locality. In Upper Lias shale, above the Jet-bed at Saltwick, near Whitby (*Phillips*). Sandsend, near Whitby (*Phillips*), and Robin Hood's Bay (*Cullen*).

A specimen in the Bristol Museum (B L, 42), is said to be from Gloucester. It closely resembles, however, Yorkshire specimens, and I have never observed the species in any locality south of Yorkshire.

Observations. By German writers this is usually supposed to be identical with some one of the many forms included under the title of *Belemnites acuarius*. Quenstedt figures, pl. xxv, figs. 2, 9, 10, specimens from the Upper Lias of Ohmden, which he terms *B. acurius tubularis*; they are uncompressed, and show a distinct ventral groove, and an undulated alveolar border. D'Orbigny includes *B. tubularis* among the many synonyms of *B. acurius* with *B. longissimus*, Mill., *gracilis*, Hehl., *lageniformis*, Hartmann, *longisulcatus*, Voltz, *tenuis*, Münt., *semistriatus*, Münt., *gracilis*, Römer. He regards the guard as subject to a remarkable extension retrally, at a certain age, previous to which it does not differ, he says, from that of *B. irregularis*. The extension is stated to be most frequently hollow, so that the term "tubularis" would be really deserved, and the compression to a flat plate easily explained. When this is not the case, from the filling of the cavity with calcareous matter (not fibrous), it constitutes the so-called *Pseudobelus* of Blainville. Such is the view of D'Orbigny, who was ready to unite *B. irregularis* and *B. acurius* in one species, the former being females, which preserved always their original obtuseness, and had no retral extension, the latter being males. This remarkable opinion he bases on an examination of the recent *Loligo subulata*, the males of which have a very long dorsal plate (osselet), the females a short one. I propose to consider this subject in a general discussion, embracing other species; but at present it appears only necessary to say, that there is no ground for admitting the specific affinity of *B. irregularis*, or any forms like it, with *B. tubularis* of the Yorkshire coast.

The length of the unflattened part of this Belemnitic guard is very unequal in different specimens of about the same total length—one example in my possession gives eight inches for this part, several three inches, one two and a half. The flattened part in one example exceeds six inches. A fine specimen obtained by the Rev. Dr. Plumptre, at Whitby, and now in the Oxford Museum, is thus measured: total length 12 inches,

apical region, grooved and flattened, 1 inch; post-alveolar region, uniformly tapering, $7\frac{1}{2}$ inches; alveolar region of visible guard, 2 inches; projection of phragmocone beyond it, $1\frac{1}{2}$ inch. The phragmocone is extended to a total length of nearly $3\frac{1}{2}$ inches, all chambered, with a terminal breadth, completely flattened, of $1\frac{1}{4}$ inch. This gives an apparent angle to the phragmocone of 27° ; but if reduced to a cone, about 18° . The diameter of the guard at the alveolar apex is about 0.375 inch; the length of the axis, twenty times as great. Nearly all the surface is striated, the striae being everywhere undulated and interrupted, and largest and most conspicuous on the alveolar region.

Another fine specimen also presented by Dr. Plumptre to the Oxford Collection is $11\frac{1}{4}$ inches long; of this the posterior $7\frac{3}{4}$ ths inches are compressed flat; 3 inches remain quite unaffected by pressure, and beyond this is 1 inch of crushed alveolar cavity. Diameter at the alveolar apex $\frac{1}{10}$ ths of an inch. Three parallel grooves, which seem to be too regular to be the effect of mere crushing, appear on a great part of the flattened post-alveolar region; toward the point only one is traceable, and it is accompanied by several striae. The grooves referred to do not extend over the solid post-alveolar and alveolar tracts; on which, however, facettes can be traced which seem to correspond with the grooves. From this it seems, on the whole, probable that the grooves are the effect of uniform pressure on the unequally resisting faceted surface of the hollow part of the guard.

The shells which commonly accompany this Belemnite are chiefly *Posidonia* (*Inoceramus dubius* of the 'Min. Conch.');

 and the shale may well be called, as in Würtemberg, where *B. acuarius* occurs in it, the Posidonian shale.

BELEMNITES ACUARIUS, *Schlotheim*. (Diagram No. 22.)

Reference. Schlotheim, 'Petref.,' p. 46, No. 2, 1820; D'Orb., 'Terrains Jurassiques,' pl. vii, referred to in his text, p. 76, as pl. v; Quenst., 'Jura,' p. 258, pl. xxxvi, fig. 9, 1857.

GUARD. Elongate, compressed, striated on the sides in the retrol part, and flattened, by compression, at the end.

Transverse section oval, with somewhat flattened sides; the ventral surface broadest, axis nearer to the ventral side.

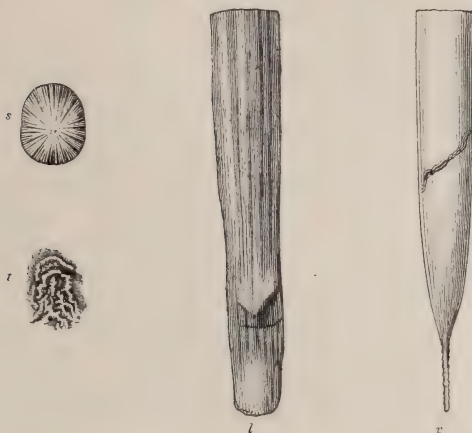
Taking the diameter from back to front at 100; the dorsal radius is 66, the ventral 34, the cross diameter 73.

PHRAGMOCONE not seen in English specimens.

Locality. Cheltenham, in the Belemnite-bed of the Lower Lias (*Buckman*).

Observations. In the figure quoted from Quenstedt the lateral striation is not

DIAGRAM 22.



represented: in other figures of Quenstedt referred to *B. acuarius* ('Cephalopoda,' pl. xxv), lateral striation is represented, but not the terminal compression. D'Orbigny, pl. vii, fig. 4, represents the retral part of the guard as tubular. These fossils belong to the Upper Lias. At *t* the winding interior structure is represented.

ON BELEMNITES ALLIED TO *B. DIGITALIS* OF SCHLOTHEIM, PLATES XV, XVI.

Few Belemnites appear on a first view more characteristically separate from the rest than the compressed, very blunt, straight-sided forms of the Upper Lias, which are frequent in the continental museums, under the name of *B. digitalis*. In only a few instances is this form exactly discovered in collections of English specimens. But the use of the term in museums and in books is such as to include a much greater variety of forms than seemed to Blainville and Voltz fairly admissible. Taking the idea of this Belemnite from the text and figures of Voltz, we have a cylindroidal, much compressed form, quite obtuse, and even-rounded to an egg-shape at the end; and upon making longitudinal sections the internal layers, after a certain age, correspond in bluntness of termination. The youngest layers end sharply. The cross section in the forward part of the alveolar region shows a remarkably thickened accretion of the sheath on the ventral aspect. There is always a ventral furrow in one variety, called *B. irregularis* by Schlotheim; and indeed the apex being sometimes umbilicate, sometimes papillary, and sometimes in

other ways of unusual appearance, the term seems natural enough, though founded in part on accidents of decomposition rather than structure.

If now we turn to Quenstedt, and examine the figures given in pl. xxvi of his 'Cephalopoden' (1849), we find the ordinary blunt compressed form, with its various inner and outer aspects clearly represented (pl. xxvi, figs. 1—7.) Another is given, somewhat longer and less obtuse (pl. xxvi, fig. 8); again, one somewhat bowed at the end (pl. xxvi, fig. 11), called *B. digitalis acutus*; and a closely allied form (pl. xxvi, fig. 65), which shows traces of lateral furrows, receives the name of *B. incurvatus*. Finally, a longitudinal section (pl. xxvi, fig. 14 c), and two drawings of the lateral aspect of somewhat larger and more pointed specimens, with ventral and dorso-lateral grooves, complete the series of varieties under the title of *B. digitalis tripartitus*. Of all these Belemnites, which are found only in the Lias, I have seen examples from English localities. Only a very small number correspond strictly to *B. irregularis* of Schlotheim, but there is a great number and variety comprised within the limits of the additional forms of Quenstedt. The middle term of all the varieties agrees with some specimens which are frequent at Whitby, called *B. vulgaris* by Young and Bird. I possess only one specimen from Whitby at all approaching to *B. digitalis* in the extreme bluntness and irregularity of the end, which is obscurely marked by a ventral groove, and is eroded. It was taken from the Upper Lias of Saltwick.

BELEMNITES IRREGULARIS, *Schlotheim*. Pl. XV, figs. 37, 39.

- Reference.* *Belemnites digitalis*. 'Faure Biguet,' 1810 (as quoted by Blainville in 1827, but disallowed by D'Orbigny, 1860).
B. irregularis, Schl. 'Taschenbuch,' p. 70, pl. iii, fig. 2, 1813, and 'Petref.,' p. 48, No. 5, 1820.
B. digitalis, Blainv., p. 88, pl. iii, figs. 5, 6, 1827.
 „ Voltz, p. 46, pl. ii, fig. 5, 1830.
B. irregularis, D'Orbigny, 'Pal. Fr. Cephal.,' p. 74, pl. iv, figs. 2—8, 1842.
B. digitalis et *B. digitalis irregularis*, Quenstedt, 'Ceph.,' p. 416, pl. xxvi, figs. 1—8, 1849.

GUARD. Short, straight, cylindroidal, much compressed; apex oblique and very blunt in the adult, often marked by a tubercular and pitted surface, from which vermicular ridges and hollows radiate to a short distance. Apex in younger specimens often sub-mucronate, in very young examples acute. On most specimens there is one short ventral furrow near the apex; no dorso-lateral grooves at the apex.

Transverse sections elliptical, with flattened sides; across the anterior part of the alveolar region, the unequal thickness of the ventral and dorsal parts of the guard is often conspicuous; and, what is remarkable, in specimens which have the one short apical furrow, it is on this side that the thickening is greatest. Such a groove usually indicates the ventral aspect, and it is so figured by Quenstedt ('Cephal.,' pl. xxvi, fig. 1 *d*). Voltz, who observed this unequal thickening, and paid much attention to it, states that, while from the apex toward the alveolar cavity the deposited layers thicken most of all the dorsal parts, and least of all the ventral, it is quite otherwise in the alveolar region, where the augmentation takes place on the ventral part (Voltz, 'Obs. sur les Bel.,' p. 47, and pl. ii, fig. 5 *F*'). He also remarks that the "summit" is oblique, and nearer to the ventral than to the dorsal aspect. I find, indeed, that it is on this side, toward which the apex is inclined, that the short apical groove occurs, when it does occur, contrary to what is usual; and it is on this side that the circum-alveolar space is thickened. Before, however, deciding that Voltz is altogether right in this observation, I wish to obtain specimens from the Upper Lias of Gloucestershire, which may be properly cut for examination.

In a longitudinal section, the axis is seen to be very oblique, a little arched toward and near to the ventral side, and marked by a pale tint in the laminæ about it—probably they were less calcareous.

Proportions in the adult. Taking the dorso-ventral diameter at the alveolar apex at 100, the ventral part is 40, the dorsal part 60, the cross diameter 80, the axis 180 to 220.

PHRAGMOcone. Oval in section, slightly arched toward the ventral region, and terminated by a spherule; the angle of inclination of the sides 25° according to Voltz, 20° to 22° according to D'Orbigny. Voltz describes the summit of the dorsal "ogives" as nearly rectangular. The diameters are 100 to 87.

VARIETIES. *a.* Short, with obtuse ovoid summit inclined toward the grooved side of the apex (Pl. XV, fig. 37).

β. Longer, with obtuse summit (Pl. XV, fig. 39).

Locality, var. a., short, obtuse. Frocester Hill (Sands), in the Cabinet of Bristol Institution, two specimens marked B 1, No. 28. Also two specimens from the same locality, in the Cabinet of Mr. Moore, one of them longer in proportion.

BELEMNITES REGULARIS, n. s. Pl. XV, fig. 38.

GUARD. Straight, cylindroidal, tapering in a curve to the end, compressed, with an oval or elliptical section, and a three-grooved, somewhat striated, unbilicated termination;

ventral aspect rather narrower than the dorsal (adult) ; no recurvation of the apex, which is divided by the grooves.

Sections across the alveolar cavity show the slightly oval alveolar section within the oval or elliptical outline of the guard—the oval outline being caused by the contraction of the ventral region ; sides flattened.

Dimensions. Length of guard before it shows any alveolar expansion, $2\frac{1}{2}$ inches, of which the axis is about $1\frac{1}{4}$ inch ; the diameter from back to front being in the largest specimen $\frac{7}{10}$ this inch.

Proportions. The dorso-ventral diameter at the apex of alveolus being taken at 100, the cross diameter is 85, the ventral radius about 40, the dorsal about 60, the axis 250 (in the larger variety 300 to 400).

Locality. Upper Lias Clays at Eydon (one), and Badby (three), near Banbury (Stuttard).

Observations. The affinity of this tripartite fossil to that so frequent at Whitby (*B. vulgaris*) is obvious ; while its parallel sides and greater compression offer analogies to the less obtuse examples of *B. digitalis*, like Quenstedt, pl. xxvi, fig. 11, and *B. incurvatus*, fig. 15, on the same plate.

As in *B. vulgaris*, so in this, the axis of the guard varies in length in proportion to the diameter. There is a series of more slender forms in Mr. Stuttard's collection from Eydon and Badby, in which the axis measures 320, 350, 400, no other difference being evident ; e. g. (Nos. 50, 51, 58), Fig. 38 *b* shows one of the shortest of these slender forms, with ventral groove longer and more distinct than usual.

Young specimens (Nos. 53 and 63) from Eydon and Badby have the axis remarkably excentric, in the proportion 28 to 72, the interior nearly circular, sides somewhat channelled, termination acute, ventral sulcus distinct, the others variable ; in one, dorsal plaits. The axis exceeds 600. They resemble almost exactly some young cylindroid varieties of *B. subaduncatus*, with the same excentricity. The older specimens referred to also correspond very much with the older cylindroid specimens of *B. subaduncatus*. Thus they constitute a parallel series ; and taking the whole into account, we have this general comparison of these tripartite forms :

Whitby, more or less recurved :

Short form, *B. vulgaris*, Pl. XVI, fig. 40.

Long form, *B. vulgaris*, Pl. XVI, fig. 41.

„ *B. subaduncatus*, Pl. XI, fig. 29.

Banbury, little or not at all recurved :

Short form, *B. regularis*, Pl. XV, fig. 38 *a*.

Long form „ „ fig. 38 *b*.

BELEMNITES VULGARIS, *Young and Bird*. Pl. XVI, figs. 40, 41.

Reference. *Belemnites vulgaris*, Young and Bird, Yorkshire Coast, p. 258, pl. xiv, fig. 1, 1st ed., 1822; 2nd ed., p. 275, pl. xv, fig. 1, 1828.

„ „ Simpson, 'Lias Fossils,' No. 23, p. 28, 1855.

B. curtus, Simpson, 'Lias Fossils,' No. 24, p. 29, 1849.

B. incurvatus, Quenstedt, 'Cephal.,' p. 418, pl. xxvi, fig. 15.

GUARD. Short, compressed, tapering in a curve to the apex, which in perfect young specimens is acute, but in older examples always somewhat obtuse; lateral furrows distinct for short distance only, ventral furrow present and distinct for a short space in one variety, obscure or almost obsolete in another.

Transverse sections show the contour to be more variable in different parts of the guard than is usual. At the apex of the alveolus the outline is oval, with more or less flattened sides somewhat inclined to one another, the ventral breadth being less than the dorsal; the axis excentric. Toward the apex the ventral region increases in amplitude, and the contour changes still more toward the apex, there showing three emarginations corresponding to the three grooves. This gives on the whole an irregularity to the surface-curves which is less manifest in other species, but is nevertheless often to be recognised in some of them.

Longitudinal sections show the form to have been little, if at all, changed by growth; the inner outlines, down to $\frac{1}{2}$ an inch of axis of guard, giving nearly the same proportions as the outer surface of a specimen with four times as long an axis.

Greatest length observed 6 inches, including the expanded part of the guard; greatest length of axis, commonly under 2 inches.

Proportions. Taking the dorso-ventral diameter at the alveolar apex at 100, the ventral radius is about 45, the dorsal about 55, the cross diameter 80, the axis usually 200, 225, 250, 275.

Young. I have found it difficult to trace this species through its younger forms by selection of specimens on the Scars of Whitby and Saltwick. It appears, however, by sections to vary but little with age. In my youngest specimen the axis of the guard is less than 1 inch long, the normal diameter $\frac{2}{3}$ ths—proportions which are also found in older specimens.

PHRAGMOCONE. Oblique, a little arched, with an elliptical section; sides converging 19° in the anterior parts, and 22° near the apex. The axis of the phragmocone in two specimens is more than twice as long as the axis of the guard. The diameters are as 95 to 100, or in some examples almost equal. The depth of the inter-septal spaces is commonly $\frac{1}{2}$ th of the long diameter near the apex; but in one specimen at a more advanced

part of the cone it is $\frac{1}{10}$ th. The conotheca is finely striated and broadly undulated across the ventral region, longitudinally striated on the dorsal region, and there marked by a slightly prominent mesial linear band. Fifty-five septa were counted in the space of half an inch from the apex of the phragmocone.

Observations. This very common Belemnite varies as to the apex, which in young examples is acute, or even a little produced, while in old specimens it is always obtuse; there is always a tendency to greater curvature toward the apex in the ventral than in the dorsal region; the distinctness of the grooves varies; especially this is the case with the ventral groove, which is occasionally almost obsolete. Simpson marks two varieties, viz.:

- a. Two grooves and numerous fine striæ at the apex.
- b. Three distinct grooves at the apex.

These varieties occur together in the Upper Lias near Whitby; I find the striation to occur in both in good young specimens; the differences as to the ventral groove are such as to unite the whole into one group, though in that particular the extreme examples appear distinct enough. The apex is often eroded, so as to be, in the sense of Blainville, umbilicate.

The account of this Belemnite given by Young and Bird requires some elucidation. In the first edition of their work it is illustrated by two figures, one (pl. v, fig. 6) representing the guard engaged in a mass of Pentacrinites from the lower part of the Upper Lias—a fair specimen of Mr. Bird's talents as an artist; the other (pl. xiv, fig. 1) not so well drawn, but showing the exerted phragmocone. These two figures represent two distinct forms—distinct varieties at least. In the second edition, only one figure is given (pl. xv, fig. 1), and that not so good as either of those previously published. In the text of both editions a careful description is given; one of the references is to *B. elongatus* of Miller, certainly an error. The length is said to reach 10 or 12 inches, with a diameter of 2 inches at the broad end, but this must be very unusual.

Locality. Whitby, Saltwick, Sandsend, and other places in the Upper Lias of Yorkshire, at various stages above the Jet-beds, up to and including the Leda-beds (*Young and Bird, Simpson, Phillips*). These show two varieties as to length, the axis of the guard being proportionately shorter in fig. 40, and longer in fig. 41.

BELEMNITES RUDIS, n. s. Pl. XVI, fig. 42.

GUARD. Short, somewhat compressed, and oval in section, with or without one short obscure apical groove; no dorso-lateral grooves. Adult specimens blunt at the end.

Sections across the alveolar region (Pl. XVI, fig. s') show the slightly oval outline

of the phragmocone within the slightly oval guard, which is thickened on the dorsal aspect; those across the post-alveolar region show the axis to be very excentric till near the apex (Pl. XVI, figs. *s'' s'''*).

Longitudinal sections give a nearly straight axis, prolonged in the direction of the ventral line of the phragmocone.

Proportions. Taking the dorso-ventral diameter at the alveolar apex at 100, the ventral part is less than 40, the dorsal more than 60, the cross diameter 95, and the axis 180 to 200 (in young specimens 300). Between the apex of the phragmocone and the apex of the guard the dorsal radius is sometimes twice as long as the ventral.

PHRAGMOCONE. Somewhat oval in section, slightly arched toward the ventral side; angle 28° .

Locality. Very abundant in ironstone-beds belonging to Middle Lias, between the jet-rock and marlstone, east of Staithes, Yorkshire (*Phillips*).

ON A GROUP OF BELEMNITES ALLIED TO *BELEMNITES COMPRESSUS* OF BLAINVILLE AND VOLTZ.

The title "*Belemnites compressus*" appears to have been first used by Stahl, as already noticed, p. 41. But the papers of this author in the 'Correspondenzblatt der Würt. Landw. Vereins,' 1824, attracted little notice, and the greater number of Belemnitologists followed the example of Blainville, 1827, who gave the name of "*compressus*" to a different species, belonging to a different group. In his description the essential points are as follows:

Shell straight, very compressed, so that the vertical diameter is much greater than the transverse, and the section is oval; apex medial, straight, with a broad shallow groove on each side, dying out by degrees toward the alveolar region; alveolar cavity conical, with an oval section, six inches and more long. Pl. ii, figs. 9 and 9 *a*, of Blainville's work represent the Belemnite laterally and in cross section. From these figures I infer that the axis of the guard was above three times as long as the diameter at the apex of the phragmocone. Such a specimen may be found in the sandy beds at the base of the Lower Oolite of Yorkshire, while in a higher calcareous rock occurs another and allied form, with five furrows at the apex, called by Blainville *B. quinesulcatus*, and represented in his work, pl. ii, figs. 8, 8 *a*, 8 *b*.

Voltz, writing in 1850, gives a general character of *B. compressus*, and places under this title three varieties. The general characters are these:

Sheath large, straight, conoidal or conical, compressed, with an oval cross section in the alveolar region. Summit straight, *emoussé*, furnished with two dorso-lateral furrows, which pass over at least one third of the apical region. Axis of the guard excentric,

approaching the ventral side at its origin, and then bending toward the back and becoming subcentral. Phragmocone depressed, inclined toward the ventral side. The three varieties are—

- Var. A. *B. compressus*, Blainville, pl. ii, fig. 9 (Sand below Inferior Oolite).
 „ B. *B. compressus*, Voltz, pl. v, fig. 2 (Upper Lias).
 „ C. *B. compressus*, Voltz, pl. v, fig. 1 (Upper Lias).

The varieties B and C are fully described. The former has a perfectly conical sheath, much striated at the point, the striæ continuing on the shell nearly as long as the grooves, viz. for half the length of the apical region. In the latter variety the sheath is conoidal, and the striæ are described as plaits about ten in number. The phragmocone in var. B is straight, the sides meeting at an angle of 26° ; in C it is a little arched, and the sides meet at an angle of 29° . Ventral furrows were not observed in any of the specimens, which, except in this particular, appear very similar to examples from the Upper Lias of Yorkshire.

Quenstedt (1848) has treated this perplexing subject with attention. He employs the title of *B. compressus* for the fossils described by Voltz, from which he separates those of Blainville, and uses such compound terms as *B. compressus gigas*, *B. compressus pavillosus*, and *B. compressus conicus*, for allied forms of the same natural group.

We have in the English Lower Oolites and Upper Lias plenty of examples of this group of “compressed Belemnites,” but they have not been strictly studied and compared.

Mr. James de Carle Sowerby, in 1829, represented the fossils from the Oolite of White Nab, near Scarborough (‘Min. Conch.,’ pl. 590, fig. 4), under the name of *B. compressus* of Blainville. Professor Morris, in his ‘Catalogue of British Fossils’ (1854), refers the same specimens to *B. giganteus* of Schlotheim. Since that date D’Orbigny (1860) has collected under the same title *B. ellipticus* of Miller, *B. compressus* of Sowerby, *B. quinquesulcatus* and *gigas* of Blainville, *B. gladius* of Deshayes, *B. Aalensis* and *longus* of Voltz, *B. grandis* and *acuminatus* of Schubler, *B. bipartitus* and *canaliculatus*, of Hartmann; but this is not a method to be recommended. This is not a species, but a group of species, whose geological range includes the Upper Lias and the Lower Oolite.

Under *B. compressus* of Blainville D’Orbigny ranged also *B. apicicurvatus* and *B. bicanaliculatus* of that author, *B. crassus* of Voltz, and *B. bisulcatus* and *B. tumidus* of Zieten.

It appears to me that three distinct British forms may be well marked among the varieties of Belemnites properly referred to *B. compressus* of Blainville and Voltz; one is described by the first author; another includes the varieties B and C of Voltz; the third is now illustrated from Yorkshire specimens.

BELEMNITES VOLTZII, n. s. Pl. XVII, fig. 43.

Reference. *Belemnites compressus*, Voltz, var. B and c, 'Belemn.,' p. 53, pl. v, figs. 1 and 2, 1830.

GUARD. Conoidal, compressed, smooth, with a central blunt or eroded termination (when old). Two dorso-lateral furrows proceed along half the space of the apical region, and from the termination about ten small plaits extend to half the length of the furrows. No ventral sulcus.

Transverse sections show at the alveolar apex a regularly oval contour, the innermost layers of the guard undulated by the dorso-lateral furrows.

Longitudinal sections show the axis to be excentric, most so at the alveolar apex, from which it is reflected toward the back, and then continues subcentral to the end. The inner and younger laminae end bluntly in arches, so as to indicate the young forms to have been obtuse at the termination (Voltz made this remark, page 55 of his work).

Greatest length observed, 5 inches, the diameter at the extremity being 1.2 inch.

Proportions. Taking the diameter from back to front at the alveolar apex at 100, the cross diameter is about 90, the ventral radius 40, the dorsal 60. The axis in variety B, Voltz (shorter and smaller variety), is 250; in the longer and larger variety, C, 350.

PHRAGMOCONE. Nearly straight in var. B, slightly arched in var. C; in var. B the dorsal region occupies one sixth of the circumference, in var. C one fourth; in B the hyperbolar regions occupy the twelfth of the circumference, in C one eighth. In var. C, along the band which separates the hyperbolar from the ventral region occur small striæ, which cross the hyperbolic arcs. Of these Voltz says he could give no explanation. (See *B. inornatus*.)

Locality. I am not sure that specimens exactly corresponding with this description, and constantly deficient of the ventral sulcus, have come under my notice from any locality in England. One cause of this doubt is the uncertainty about the younger forms; for while Voltz infers, from longitudinal sections, that the apex was always blunt in var. B, and that in var. C it became blunt with age, we find Quenstedt referring to figures of the young which are quite acute, with a very deep alveolus and very short axis ('Cephalopoden,' p. 422, pl. xxvii, figs. 13, 17). But as he speaks also of the early appearance of the dorsal furrows and of the later appearance of the ventral furrows, "which sometimes become extraordinarily deep," it would seem to be the form here called *ventralis* which he is describing.

On the Scars at Whitby and Saltwick are many Belemnites which might be thought

the young of the Voltzian shells, being quite devoid of ventral sulcus, but they are commonly acute, and not striated; others, which are acute and striated, with a ventral sulcus, may be thought to be the young of *B. ventralis*.

BELEMNITES VENTRALIS, n. s. Pl. XVII, figs. 44, 45.

GUARD. Conoidal, compressed, smooth, with a central blunt or eroded termination (when old). Two dorso-lateral furrows and one medio-ventral groove proceed along nearly half the space between the end of the guard and the end of the alveolus. The termination is striated, and the striæ extend to about half the length of the grooves.

Transverse sections at the apex of the alveolus show the axis excentric and the contour regularly oval; the ventral side rather narrower than the dorsal in the medial region, but wider in the part near the apex. Further backward the section shows the effect of the ventral and lateral grooves. The axis is nearly straight. The greatest observed length, including about one third of the phragmocone, is 6 inches; the greatest diameter $1\frac{1}{4}$ inch.

Proportions. The diameter (*v d*) at the apex of the alveolus being taken at 100, the ventral radius is 41, the dorsal 59, the axis 300 to 350, the cross diameter 90.

PHRAGMOCONE. Slightly arched, ending in a spherule, with a slightly oval section (100 to 95 or 90); septa obliquely descending to the siphuncle, and waved on the edge; the depth of the chambers equal to one seventh of the diameter. The sides are inclined to each other 21° . The conothecal striation is very distinct.

Locality. Upper Lias of Whitby, Saltwick, and Robin Hood's Bay (*Phillips*). Frocester Hill Sands (*Moore*). Not observed at Lyme Regis (*Phillips*).

BELEMNITES INORNATUS, n. s. Pl. XVIII, fig. 46.

Reference. *Belemnites compressus*, Blainville, 'Belemn.', p. 84, pl. ii, fig. 9, 1825.

GUARD. Conoidal, compressed, smooth, with a blunt or eroded termination (when old). Two dorso-lateral furrows proceed along one third of the apical space. No ventral furrow, no striæ about the termination.

Transverse sections at the apex of the alveolus give an excentric axis and a regularly oval contour, the ventral portion being rather narrower than the dorsal. Toward the apex the lateral grooves indent the outline.

Greatest length observed, 4.65 inches, of which the axis is 2.65.

Proportions. The long diameter at the apex of the alveolus being taken at 100, the ventral radius is 42, the dorsal 58, the cross diameter 75 to 84, the axis 220, 250, 280. In an extreme case, a more lengthened specimen than usual, the axis is 360, and there is a further peculiarity to be noticed—a short dorsal groove.

PHRAGMOCONE. Somewhat remarkable for smoothness on the dorsal and dorso-lateral regions; for the ellipticity of the cross section, which augments toward the aperture, the axis appearing to be there in the proportion of 100 to 90; and for the small depth of the interseptal spaces, which are about one ninth of the diameter. In the first quarter of an inch from the apex are about 30 septa, in the second quarter 10, in the third quarter 7, in the fourth 5, in the fifth 4. The right and left sides of the phragmocone are straight, the ventral face very little concave, the dorsal very little convex.

The ventral portion of the conotheca, half the circumference, is undulated across by the convexity of the interseptal spaces, and finely striated both parallel to the undulations and lengthways. At the boundary between the ventral and lateral spaces these striae turn up suddenly across the band (which is marked by two or three longitudinal straight lines), to join into and form the hyperbolic arcs, which are traced accurately to the asymptote. Along the band here referred to the striation appears complicated, and this probably is what Voltz refers to in his account of *B. compressus*, var. c, as already noticed. Beyond this the forward-bent arcs undulate the dorsal region, and are crossed by numerous longitudinal striae, which are most distinct on the middle of the back.

VARIETIES. In general figure some specimens are nearly straight-sided, others are more convex in the middle of the apical region, and more rounded toward the apex, which appears to be always blunt and central. The more convex the medio-apical space, the shorter is the axis in comparison with the diameter. One of my specimens is very compressed, so that the cross section at the apex of the alveolus gives an ellipse of 100 to 75. The axis in this case measures 240.

One of my specimens from Blue Wick, which has the extreme length of axis already referred to, is remarkable for a short *dorsal* groove, corresponding in situation to that already noticed in *B. dorsalis*, p. 58, viz. the lower alveolar region.

Locality. In the Sandy Cap-beds of the Lias at Blue Wick, with *Vermicularia compressa* (Bean, Phillips, Cullen). In the Sands at Nailsworth (Moore).

Remarks. Though I have described these interesting fossils under three specific names, and think it most convenient to do so, it may possibly happen that more complete inquiry may lead me to regard them as varieties of one species, known as *B. compressus*, a name very appropriate, but already pre-engaged by Stahl. If this view should finally prevail, a new comprehensive name will be required, and I hope the title of "Voltzii"

may in that case be accepted, as a just tribute to one of the best of Belemnitologists. We should then have—

Belemnites Voltzii, var. *conicus*, Pl. XVII, fig. 43.
 „ var. *ventralis*, „ figs. 44, 45.
 „ var. *inornatus*, Pl. XVIII, fig. 46.

In coming to this conclusion we might be confirmed by some other instances of the variability of the ventral sulcus, and it appears to me very interesting and significant to notice the loss of this furrow in passing from the upper part of the Lias to the lower part of the Oolites, which is immediately superposed, while above these lower beds no Liassic forms recur, but a new series of Belemnites begins. In general form we may remark in some specimens convex outlines in the retral slopes of the ventral and dorsal faces near the apex, in others this same part is quite straight-sided, or even a little produced, so as to approach the figure of *B. longisulcatus* of Voltz (pl. vi, fig. 1). But a more important circumstance, already mentioned, is the presence or absence of the ventral groove. In the very uppermost part of the argillaceous Lias beds of Whitby, which contain *Leda ovum*, I found specimens all sulcated on the lower side; in the lowest sandy Oolitic Dogger of Blue Wick I found others not sulcated—this being the main difference which I observe. In a series of these Belemnites lately collected for me by Mr. Peter Cullen the same fact appears. On examination it appears that striation of the apex commonly accompanies the ventro-sulcate variety, and commonly is absent from the other. What appear to be rather young examples of both forms are frequent in all the Upper Lias beds of Whitby, but large specimens are rare there. The younger examples are very acute at the end, the older specimens commonly obtuse or worn or truncated, just as Voltz represents his examples from Gündershofen.

BELEMNITES LONGISULCATUS, *Voltz*. Pl. XIX, fig. 47.

Reference. *Belemnites longisulcatus*, Voltz, 'Belemn.', p. 57, pl. vi, fig. 1, 1830.
B. acuarius longisulcatus, Quenstedt, 'Cephal.', p. 412, pl. xxv, f. 23, 1849.

GUARD. Conoidal, straight-sided, much elongated, much compressed, rounded at the end, with two dorso-lateral furrows, three dorsal, and five ventral plaits; the dorso-lateral furrows occupy more than half the length, the plaits one fourth of the length; axis subcentral.

Transverse section oval, axis but little excentric; taking the diameter at the alveolar apex as 100, the axis is 500 or 600.

PHRAGMOcone. Straight-sided, angle 25° . Dorsal area less than one fourth, lateral area one eighth of the circumference. Septa approximate.

This description is mostly from Voltz, who had one complete guard to examine from the Upper Lias of Wurtemberg. That this species occurs in the Upper Lias, on the Yorkshire coast, I have no doubt, but no good specimens have come to my hands. I therefore copy the figures of M. Voltz. It is decidedly analogous to *B. compressus* of that author, but longer. In the Museum at Whitby is a specimen, No. 454, which agrees in general with the description and figure of Voltz, but it has a very long apical groove on the ventral aspect. It is named *B. inæquistriatus* by Mr. Simpson, and bears to *B. longisulcatus* the same relation that *B. ventralis* bears to *B. compressus*, b and c, of Voltz. In the same Museum is a specimen called "*B. compressus*, Young and Bird," with many longitudinal striæ on the flattened apical region. I made hasty sketches of these, and think one of them of sufficient interest to be here reproduced and described.

BELEMNITES INÆQUISTRIATUS, *Simpson*. Pl. XIX, fig. 48.

Reference. *Belemnites inæquistriatus*, Simpson, 'Lias Fossils,' No. 3, p. 24, 1855.

B. acuarii tricanaliculatus, Quenstedt, 'Cephal.,' p. 414, pl. xxv, figs. 13, 14, 15, 1849.

GUARD. Conoidal, uniformly tapering, much compressed, much elongated, obtuse at the end, with two dorso-lateral furrows, one ventral furrow, and several striæ. The ventral furrow extends over more than half the apical space, the dorso-lateral furrow over one fourth, and the striæ equal or exceed these in length. The furrows are narrow and very distinct, making the section tripartite near the apex. The axis is above six times as long as the diameter at the alveolar apex. Greatest length observed, 6 inches.

PHRAGMOcone. UNKNOWN.

Locality. Upper Lias of Whitby (*Simpson*).

Observations. Closely allied to this, if not identical, is *B. erosus* of Simpson ('Lias Fossils,' No. 5), of which a specimen is to be seen in the Whitby Museum (No. 56); and perhaps the same may be said both of *B. compressus* of that author ('Lias Fossils,' No. 2) and *B. concavus* ('Lias Fossils,' No. 4), but this I leave for further inquiry.

BELEMNITES SULCI-STYLUS, n. s. Pl. XIX, fig. 49.

Reference. *Belemnites acuarii macer*, Quenstedt, 'Cephal.,' p. 414, pl. xxv, fig. 21, 1849.

GUARD. Very compressed, suddenly contracted behind the alveolar region, thence

extended in a slender cylindrical form backward, and marked with two long, conspicuous, lateral grooves. (No striæ seen.)

In the transverse section of the sheath, immediately behind the alveolar region, the outline is oval, the dorsal aspect being widest. Ventral radius 45, dorsal radius 55, transverse diameter 80, axis 850.

PHRAGMOCONE. Unknown.

Locality. Only one specimen has come to my knowledge,—from Nailsworth, in the sands which cap the Lias (*Mr. C. Moore's Cabinet*).

Remarks. *Belemnites acuarius* is a name applied to many forms of Belemnite, one of which has been already referred to as allied to *B. tubularis*—by some thought identical with it. Quenstedt's figure, now referred to, appears certainly to agree with the Nailsworth specimen, and with no other that I have seen from English localities. Another figure of Quenstedt's may probably be regarded as belonging to the species (*B. acuarius longisulcatus*, 'Cephal.', pl. xxv, fig. 11), and fig. 12 of the same plate, which is striated, may, perhaps, be added to this reference. I shall be glad to hear of more specimens from the English Lias and Liassic Sands.

It appears necessary to mark this by a definite name—"acuarius" being already used in the sense of D'Orbigny, "*macer*" being also employed by Mayer. I propose the epithet "*sulci-stylus*" for the smooth, compressed, grooved forms, with cylindroid extension of the guard, not capable of being flattened by pressure. I regard this flattening as a mark of imperfect original calcification characteristic of a small number of these elongated Belemnites, chiefly of the Upper Lias.

BELEMNITES ELEGANS, *Simpson*. Pl. XX, fig. 50.

Reference. Simpson's 'Lias Belemnites,' No. 40, p. 31, 1855.

GUARD. Compressed, subhastate; cylindroidal in the post-alveolar region, tapering from thence to an extended, striated, pointed apex; slight traces of short dorso-lateral grooves at the apex; on some specimens long, lateral, shallow grooves.

Transverse section elliptical till near the apex, where it is obscurely trilobed; axis a little excentric.

Longitudinal sections show the axis to be nearly straight, and the young to have had more uniformly tapering sides.

In young specimens the proportion of the axis appears to be nearly the same, or rather longer, but the general figure is more uniformly tapering.

Dimensions. The largest specimen from Robin Hood's Bay which I have seen is in the Whitby Museum, No. 967, 5.2 inches long, and 0.65 in diameter at the alveolar

apex. I have some nearly as large from Robin Hood's Bay, and many others of lesser magnitude from Huntcliff. My smallest specimen from Huntcliff is 1·5 inch long; and between these extremes my collection contains many examples, some more compressed than others.

Proportions. The diameter at the alveolar apex from *v* to *d* being taken at 100, the cross diameter is about or above 90, the ventral radius 40 to 44, the dorsal 60 to 56, the axis 400. Near the apex the ventral and dorsal radii become equal.

PHRAGMOCOENE. The alveolar cavity is empty in the only specimen I could afford for longitudinal section. The angle is about 28°, but near the apex 32°, the whole figure a little arched.

Locality. Toward the upper part of the Lower Lias, in Robin Hood's Bay, north side (*Simpson, Cullen*); in the same position under Huntcliff (*Phillips*). In the Marlstone beds of Staithes and Robin Hood's Bay is found a Belemnite much resembling this, though usually with more distinct dorso-lateral grooves, and less distinct special striae. It must be ranked as of the same species, and does not, I believe, occur in any higher strata of the Yorkshire coasts.

Observations. Mr. Simpson, who first noticed this form of Belemnite, describes the section as circular; it is, however, rather elliptical. He has recognised the younger forms at Robin Hood's Bay (Nos. 971, 972), as I have also done at Huntcliff. One of the specimens bearing the same name in the Whitby Museum (No. 976) is now regarded by Mr. Simpson, who discovered it at Robin Hood's Bay, as a distinct species, with the name of *B. scabrosus*. It will be described immediately. Two others in that Museum (No. 458) show no apical grooves. As already observed (page 57), this fossil is allied to *B. lævis*, —and, we may add, to *B. subtenuis* of Simpson and *B. tripartitus* of Schlotheim, though the apical plaits and grooves are usually so faint or so short as to make this analogy less obvious. From *B. lævis* its attenuated apical region may be regarded as distinctive. Specimens occur at Lyme Regis, referred by me to *B. nitidus* (p. 67), and figured as a short variety (Pl. XIII, fig. 34 *b*), which are much like this fossil, but have not the apical striae, and always present more or less of the double lateral grooving. Other specimens from Lyme, which are referred to *B. apicicurvatus*, also resemble *B. elegans*, except in the apical part of the guard.

BELEMNITES SCABROSUS, n. s. (*Simpson, MS.*) Pl. XX, fig. 51.

GUARD. Elongate, slightly compressed, fusiform, tapering to a lengthened apex; one short ventral groove, two short lateral grooves, which extend into lateral facets;

alveolar region expanded, covered with rough granulations; post-alveolar region enlarged. The grooves are distinct for about half an inch each.

Only one specimen is known, viz. "No. 976," in the Whitby Museum, of which Pl. XX, fig. 51, is a sketch. The total length is $7\frac{1}{2}$ inches, the diameter at the apex of the phragmocone less than 0.4 inch, giving a proportion of axis (as 1800 to 100 diameter) such as occurs in *Belemnites clavatus* and other very long Belemnites. In the post-alveolar enlargement the diameter becomes 0.45 inch.

Locality. Obtained by Mr. Simpson from the upper part of the Lower Lias, on the north side of Robin Hood's Bay.

Observations. It is very possible, indeed very likely, that by further research it may be proved that this really elegant Belemnite is a full-grown example of one of the claviform shells which occur in the Lower Lias of Yorkshire. With a view to settle this and some other questions, I have examined four times the beds which yield these Belemnites at the base of Huntcliff, collecting many specimens; and Mr. P. Cullen has with equal care explored for me the corresponding beds of Robin Hood's Bay. At present, looking on a hundred specimens, I am not able to furnish evidence in favour of the opinion. Mr. Simpson formerly included it with less hastate forms in the species he called *B. elegans*, but the great proportionate length of its axis is probably decisive against that alliance. The rugulosity about the alveolar region may be of some importance as a character, and yet not really diagnostic, just as in *B. tubularis* another kind of rugulosity is frequently but not constantly found on the alveolar region.

BELEMNITES CYLINDRICUS, *Simpson*. Pl. XX, fig. 52, P. l, P. v, P. d.

Reference. *Belemnites cylindricus*, Simpson, 'Lias Fossils,' No. 27, 1855.

GUARD (old). Cylindrical in the alveolar region, tapering evenly to a rather blunt, often rather recurved summit, from which two distinct short dorso-lateral grooves proceed, and lose themselves before reaching the alveolar region. In a very perfect specimen the apex is striated on the ventral and on the dorsal surface; the ventral striæ are accompanied by a short groove, not seen in any other example.

Sections show a nearly circular contour, with the axis a little excentric and straight. The ventral face is sometimes a little flattened (ventro-planate, as in *B. ventroplanus* and *B. subdepressus* of Voltz).

Greatest length observed (including an expanded part), 6 inches, of which the axis of the guard occupies 4; diameter of the cylindrical part, $\frac{1}{10}$ ths of an inch.

Young specimens are rarely seen, and are more pointed than old ones, and show hardly a trace of apical grooves or striæ.

Proportions. The diameter (*v d*) being taken at 100, the ventral radius is 40, the dorsal 60, the cross diameter 100, the axis 420.

PHRAGMOCONE. Nearly straight, with a nearly circular section; the angle $m = 25^\circ$.

Locality. In the lower part of the Upper Lias at Saltwick (*Phillips*); at Robin Hood's Bay (*Cullen*); in ironstone layers at Kettleness (*Simpson*); in the shale under the Jet-bed, plentifully; and in ironstone layers at Staithes and Rosedale (*Phillips*); in the Marlstone series below the ironstone.

Observations. The agreement of this Belemnite with that long known as *B. paxillosus* is obvious and intimate, and the resemblance of particular selected specimens is almost complete, the principal observable difference being a greater proportionate length of axis and a longer tapering to a less obtuse apex in the Yorkshire specimens.

For comparison, a specimen from Ilminster, in Mr. Moore's Cabinet, is represented fig. 52, *MI*.

Recurvation of the apex occurs in several of the specimens of *B. paxillosus*, especially in those from Ilminster; in several of the specimens of *B. cylindricus* from Rosedale, near Staithes, it is so pronounced as to approach the form of *B. aduncatus*.

On the whole, I can hardly doubt that the Yorkshire specimens agree with *B. paxillosus amalthei* of Quenstedt ('Cephal.', pl. xxiv, fig. 5); the state of conservation seldom allows of the striation of the apex to be perfectly seen, as in our representation of *B. paxillosus* (Pl. XX, fig. 52, *MI*).

B. elongatus, *B. apicicurvatus*, *B. paxillosus*, and *B. cylindricus*, taken together, compose a natural group of generally cylindrical or cylindroid forms, with dorso-lateral grooves at the apex, and plaits or striæ on the ventral and dorsal aspects (exceptionally, a deeper stria on the ventral and also on the dorsal face). They are unknown in Lower Lias, but extend from the base of the Middle Lias to the lower part of the Upper Lias, and are found in Dorsetshire, Gloucestershire, Northamptonshire, Lincolnshire, and Yorkshire.

BELEMNITES OXYCONUS, *Quenstedt*. (Diagram, No. 23, p. 88.)

Reference. *Belemnites (tripartitus) oxyconus*, Quenstedt, 'Cephalop.', p. 419, pl. xxvi, figs. 19, 20, 1849.

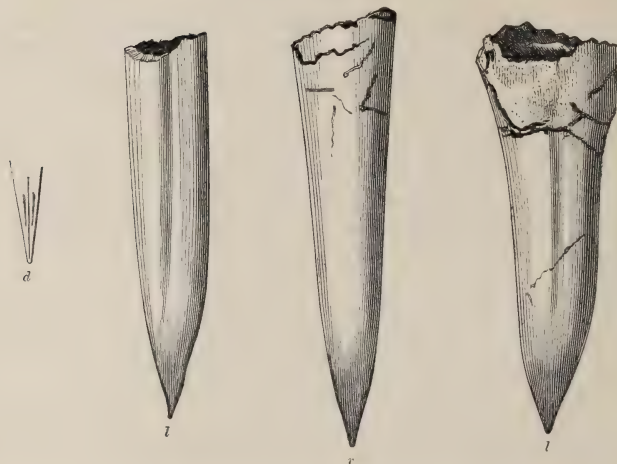
GUARD. Compressed, conoidal or conical, ending in a produced, pointed, somewhat reclined apex; lateral grooves extend over the alveolar region.

Transverse section oval, the ventral region broadest.

Locality. Cheltenham, in the Belemnite-bed of the Lower Lias (*Buckman*).

DIAGRAM 23.

Belemnites oxyconus.



The fossil here represented, from Mr. Buckman's Collection, is from the "Belemnite-bed" of the Lower Lias of Cheltenham. It corresponds to all appearance with the species referred to by Quenstedt, and I find it also to be much allied to *B. elegans* of Simpson (p. 84; and Pl. XX, fig. 50); but it is not striated about the point, as that species seems always to be; its axis is shorter, and the figure is more oblique. It seems allied to *B. acutus* of Miller, and may be the old form of that species.

EXPLANATION OF PLATE VIII.

FIG.

18. BELEMNITES BUCKLANDI, n. s.

- l*. Copy of the figure given by Dr. Buckland in his 'Bridgewater Treatise,' second edition, pl. lxi, fig. 7. In the upper part of the conotheca lies the ink-bag (opposite *i*); lower down, the phragmocone appears; and the figure is completed by the somewhat hastate guard. Lyme Regis. Collection of Miss Philpotts.
- l''*. Specimen (seen laterally) from Blue Wick. Collection of Prof. Phillips.
- l'''*. Another, from the same locality, seen laterally.
- v''*. Ventral aspect of this specimen.
- v*. Ventral aspect of a specimen which shows erosion along the face.

19. BELEMNITES MILLERI, n. s.

- l*. Lateral view of a specimen in the Oxford Museum.
- v'*. Ventral aspect of the same.
- l''*. Lateral view of a specimen in the Collection of Prof. Phillips.
- v''*. Ventral aspect of the same.
- s'*. Longitudinal section, showing the phragmocone. Oxford Museum.
- s''*. Longitudinal section of a specimen in Prof. Phillips's Collection.
- s*. Transverse section of the guard.
- a*. Umbilicated apex of a specimen.



Fig. 18

Fig. 19

EXPLANATION OF PLATE IX.

FIG.

20. BELEMNITES POLLEX.

- l.* Sketch of a specimen in the Whitby Museum. Lateral view.
- v.* Lower portion of the same, to show a broad irregular depression, and two stigmata.
- l'*. Smaller specimen, in the Collection of Prof. Phillips. Lateral view.

21. BELEMNITES ACUMINATUS (PERREUS).

- l.* Side view of a specimen in the Whitby Museum.
- s.* Transverse section, to show the nearly circular outline.

22. BELEMNITES ACUMINATUS.

- l.* Side view of a specimen in the Whitby Museum.
- d.* Dorsal aspect, near the apex.
- s.* Cross section, to show the nearly circular outline.



Fig. 21.



s



z''



Fig. 20.



z



s

Fig. 22.



d



v''

EXPLANATION OF PLATE X.

FIG.

23. BELEMNITES LÆVIS. (Whitby Museum.)

l. *Belemnites trivialis*—sketch from a specimen in the Whitby Museum.
Lateral view.

l'. *Belemnites lævis*—sketch from a specimen in the Whitby Museum. Lateral view.

v. Ventral aspect, near the apex.

d. Dorsal aspect, near the apex.

σ'. Striæ, near the apex, magnified.

σ''. Striæ broken into short plaits.

24. BELEMNITES DORSALIS, n. s. (Collection of Prof. Phillips.)

l. Lateral aspect, the specimen slightly angular.

l'. Another specimen, seen laterally.

d. A specimen seen dorsally, to show the short interrupted groove.

σ. Striated apex; not a common occurrence.

σ'. Transverse section near the alveolus.

σ''. Transverse section towards the apex.

25. BELEMNITES STRIOLATUS, n. s. (Whitby.)

l. Specimen seen laterally, with fine striæ towards the entire apex.

v. Specimen seen ventrally, with similar striæ.

σ. The striæ, magnified.

s. Transverse section.

26. BELEMNITES LÆVIS. (Whitby.)

l. Specimen seen laterally, showing striation near the apex.

v. The same, seen ventrally.

s. Longitudinal section, showing arched alveolar cavity.

φ. Section of phragmocone and spherule.

s. Transverse section.

27. BELEMNITES SUBTENUIS.

l. Side view, showing one of the long faint dorso-lateral grooves.

v. Ventral aspect, showing the faint ventral groove.

d. Dorsal aspect, showing the two dorso-lateral grooves.

σ'. Section across the alveolus.

σ''. Section across the guard, in the middle.

σ'''. Section across the guard, near the apex.

σ. Striæ, near the apex. The specimens were collected by Prof. Phillips at Saltwick, near Whitby, in Upper Lias.

Fig. 23.

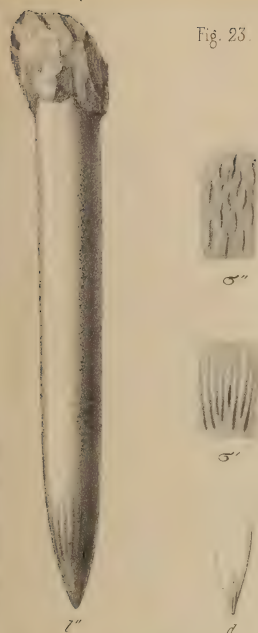


Fig. 27.

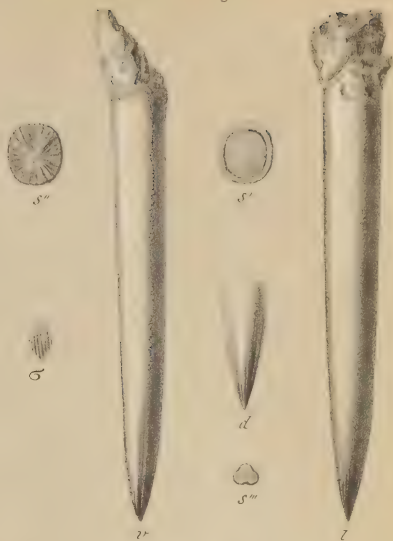


Fig. 26.



Fig. 24.

Fig. 25.

EXPLANATION OF PLATE XI.

FIG.

28. BELEMNITES TRIPARTITUS. (Whitby.)

- v.* Ventral aspect.
- d.* Dorsal aspect, showing frequent striæ.
- l.* Lateral aspect. At *v*, *d*, is the apex of the alveolus.
- s'*. Shows cross section at the alveolar apex.
- s''*. The section near the apex.
- σ.* The interrupted striation. Specimen in Prof. Phillips's Collection.

29. BELEMNITES SUBADUNCATUS, in various stages of growth. (Whitby.)

- v'*. Ventral aspect of a young specimen.
- l'*. Lateral aspect of the same.
- d.* Dorsal aspect of a very young individual.
- l''*. Lateral aspect of a more advanced and more hastate variety.
- l'''*. The same aspect of one still older.
- d'''*. Dorsal aspect of the same specimen.
- l''''*. The same aspect of one fully grown.
- s'*, *s''*, *s'''*, *s''''*. Transverse sections: *s'* being across the alveolar cavity; *s''*, at the alveolar apex; *s'''*, towards the apex, unusually excentric; *s''''*, near the apex.

Fig 28

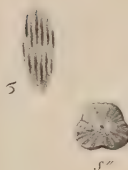


Fig 26

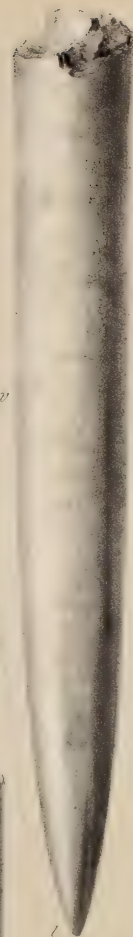
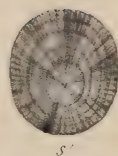
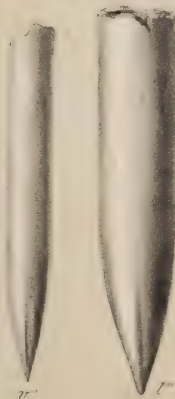


Fig 28



Fig 29

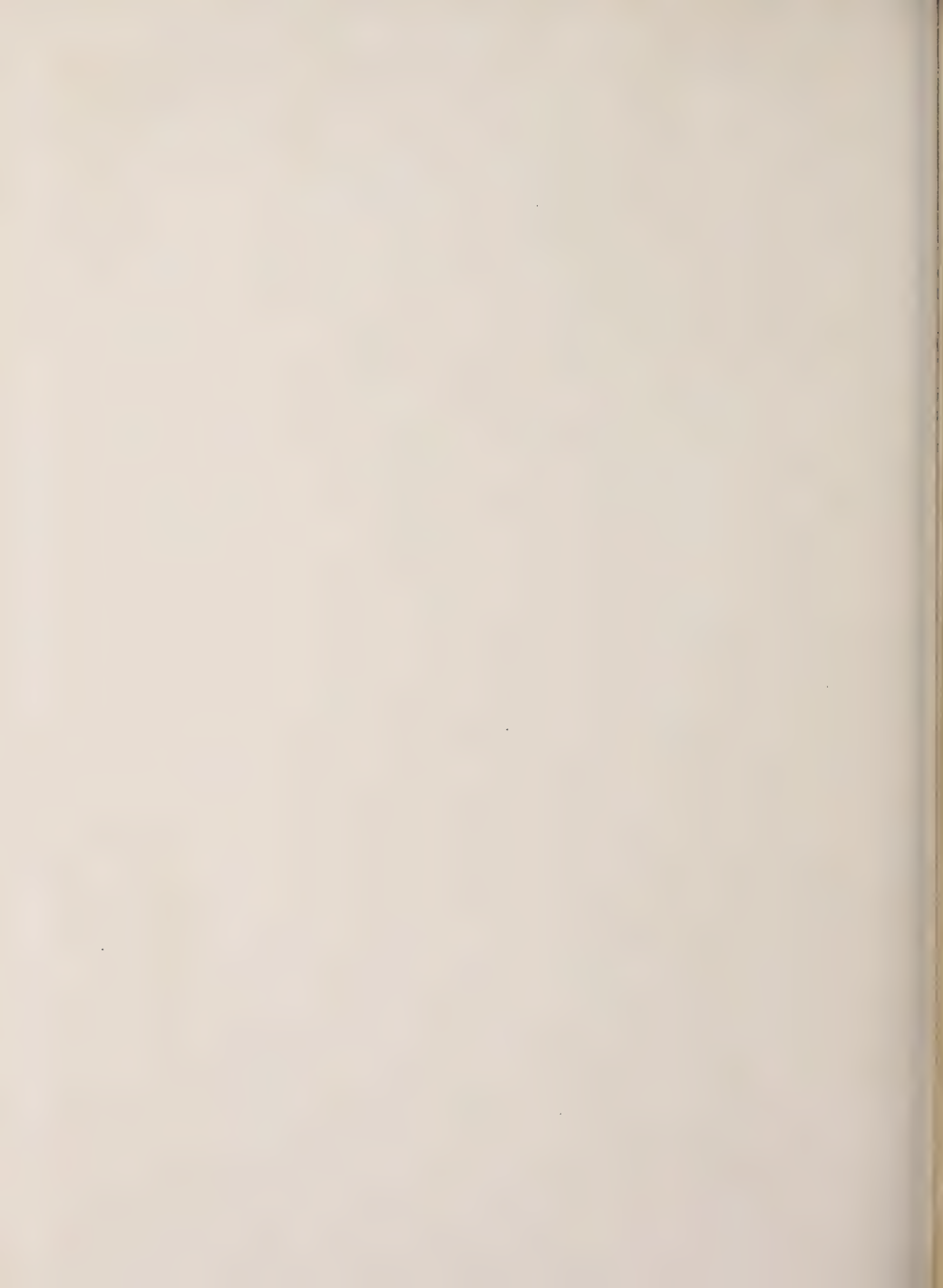


EXPLANATION OF PLATE XII.

FIG.

30. BELEMNITES ILMINSTRENSIS, n. s.

- l.* Lateral view of a fine specimen, with colour-bands, in the Collection of Mr. C. Moore.
- v'.* Ventral aspect of another example.
- l''.* Lateral aspect of a larger individual.
- v''.* Ventral aspect near the apex, showing a few striæ.
- d''.* Dorsal aspect of the same.
- d'''.* Dorsal aspect (apex rather decomposed).
- v'''* to *v^{vi}*. Series of ventral aspects in young examples.
- s.* Transverse aspect of a septum.
- s'.* " section at the alveolar apex.
- s''.* " " toward the apex.
- s'''.* " " still nearer the apex.
- s^{iv}*. " " very near to the apex.
- φ'.* Ventral aspect of the phragmocone, from which the conotheca is removed.
- φ''.* Another example, showing the dorsal aspect, with peculiar marking; this is magnified at *φ^{iv}*.
- φ'''.* Worn specimen of phragmocone, showing the shape of the siphuncle.
- φ^v*. Phragmocone *in situ*, lateral aspect.
- φ^{vi}*. Small, twin, or grouped egg-shaped prominences on the surface of the phragmocone, within the conotheca.



EXPLANATION OF PLATE XIII.

FIG.

31. *BELEMNITES MICROSTYLUS*, n. s.

- g'. Specimen belonging to the Geological Survey, and preserved in the Museum ("No. 349"), Jermyn Street. Lyme Regis.
- g''. Magnified view of the phragmocone and the enveloping sheath.
- o. Specimen in the Oxford Museum (part of Mr. Murley's Collection); from the Upper Lias of Dumbleton. The apex is broken off.

32. *BELEMNITES LONGISSIMUS*. (Lyme Regis.)

- l. Seen laterally.
- σ. The striation at the apex.
- s'. Transverse section.

33. *BELEMNITES JUNCUS*, n. s. (Lyme Regis.)

The transverse sections (*s, s'*) show concentric sheaths, with undulations corresponding to the grooves; radiating fibres obscure.

34 *a.* *BELEMNITES NITIDUS*, n. s. (Lyme Regis.) Lateral views (*l*).

The transverse section (*s'*) shows the lateral undulations and almost central axis.

34 *b.* A shorter variety, which has some affinity to *B. apicicurvatus*. Lyme Regis.

35. *BELEMNITES QUADRICANALICULATUS*. (Upper Lias [Sands], Chidcock.) Specimens in the Museum of the Geological Survey, Jermyn Street. Mr. Moore's Collection contains examples from the Upper Lias of Ilminster.

v, v', Ventral; *d, d'*, dorsal; *l, l'*, lateral.



Fig. 31



Fig. 34^a

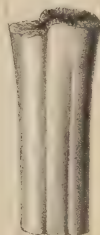


Fig. 31.

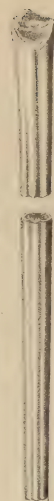


Fig. 33



Fig. 32

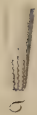


Fig. 35

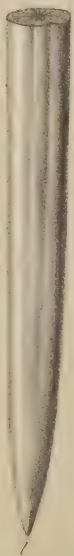
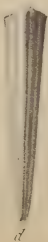
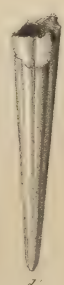
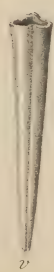


Fig. 35





EXPLANATION OF PLATE XIV.

FIG.

36. *BULEMNITES TUBULARIS*; the crushed part very long. The specimens are usually presented with a lateral aspect.

b'. Specimen from the Bristol Museum, marked, "B 1, 42. Near Gloucester."

b''. Striation on the anterior part of the guard.

b'''. Crushed portion of the guard.

b'. Specimen from Whitby, belonging to Prof. Phillips. The crushed part comparatively short; the anterior part of the guard slightly furrowed; the aspect is lateral.

b''. Opposite view of the same, showing a long dorso-lateral groove.

b'''. Ventral aspect of the same.

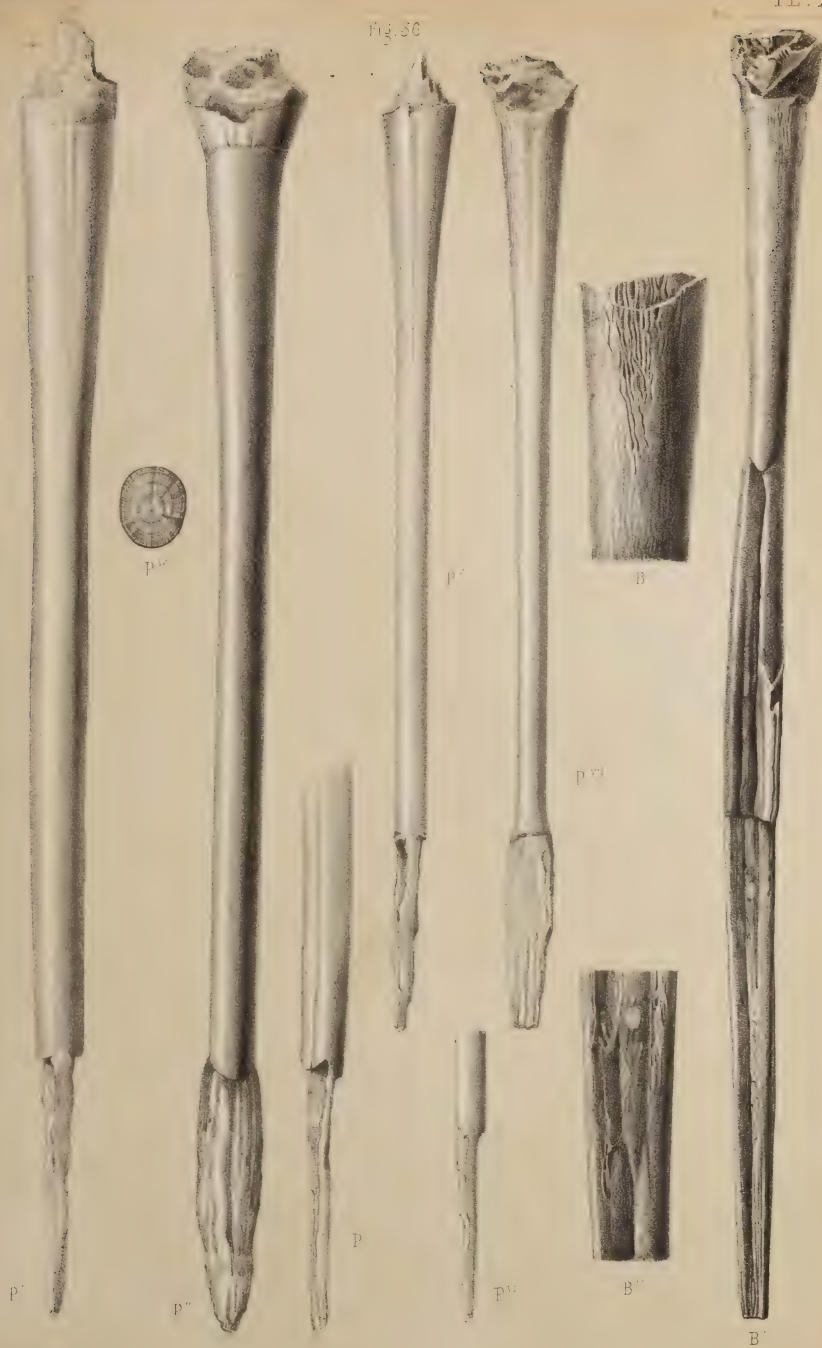
b. Transverse section at the alveolar apex.

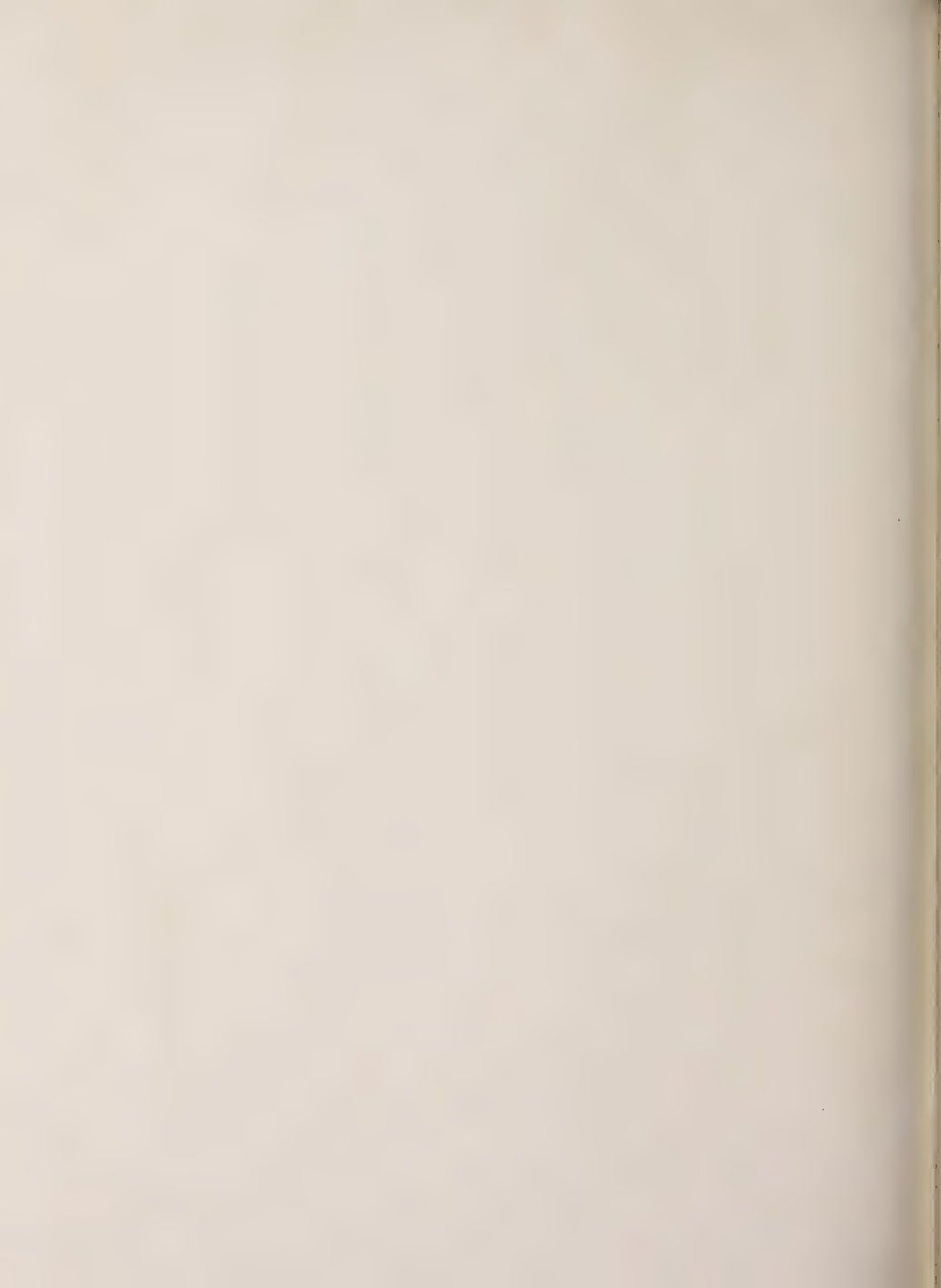
b''. Another specimen from Whitby; presented ventrally, showing some effect of pressure on the alveolar portion of the guard.

b^{vi}. Opposite aspect of the same.

b^{vii}. Lateral view of the same, showing the striation.

Fig. 30





EXPLANATION OF PLATE XV.

FIG.

37. *BELEMNITES IRREGULARIS*. Characteristic specimens in the Bristol Museum.
(From Frocester Hill.)

v. Ventral aspect.
l. Lateral aspect.
d. Dorsal aspect.
s. Transverse section of the alveolar region.
a. The apex umbilicated and striated (*g*, the mesial groove).

- 38 *a.* *BELEMNITES REGULARIS*, n. s. (From the Upper Lias, near Banbury.) (Short variety.)

l. Lateral aspect.
v. Ventral aspect.
s'. Section across the alveolar cavity.
a. The apex umbilicate and trisulcate.

- 38 *b.* Longer variety of the same.

l. Lateral aspect.
v. Ventral aspect.
s'. Section across the alveolar cavity.

39. *BELEMNITES IRREGULARIS*. (From Frocester Hill.)

l. Lateral aspect.
v. Ventral aspect of a larger variety.
s'. Section across the alveolar cavity.

Fig. 37.



Fig. 38^a.

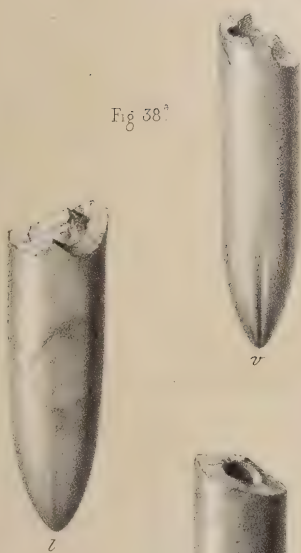


Fig. 38^b.

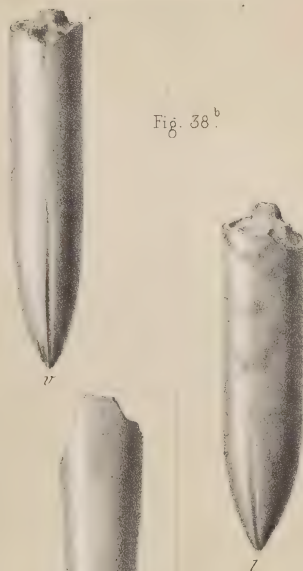
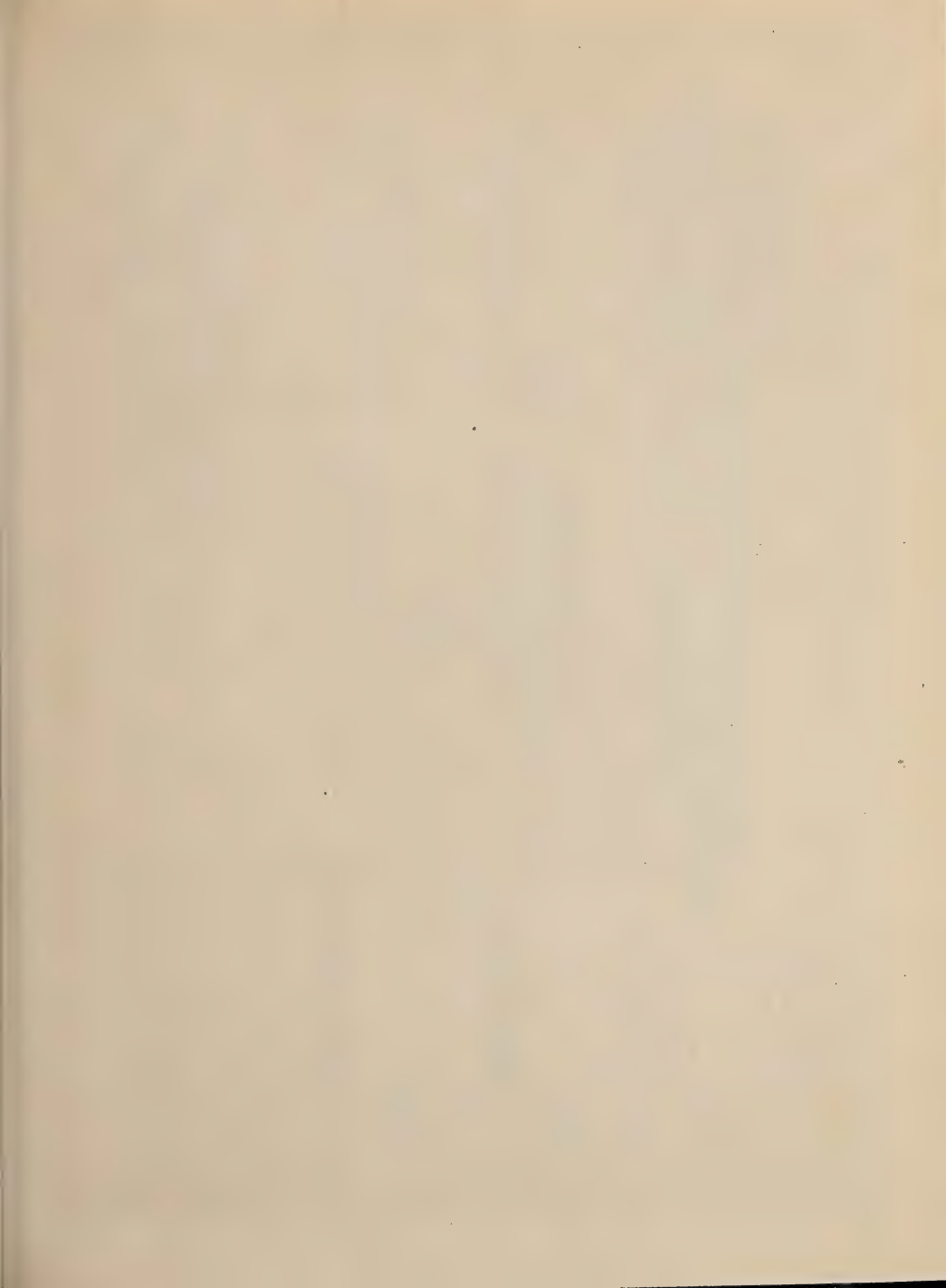


Fig. 39.





EXPLANATION OF PLATE XVI.

FIG.

40. BELEMNITES VULGARIS. (From the Upper Lias of Whitby.)

- l.* Lateral and (*v*) ventral aspects of an ordinary middle-aged specimen.
- s'*. Section across the alveolar cavity; in this case the ventral wall is thickest.
- s''*. Section at the alveolar apex.
- l'*. Lateral view of a young example.
- s.* Longitudinal section.
- φ.* Phragmocone, *in situ*, of a large specimen, with short axis of guard.

41. Lateral view of a somewhat longer individual.

42. BELEMNITES RUDIS, n. s. (From Staithes, near Whitby.)

- l.* Lateral view of an ordinary specimen; the upper outline is supposed to be the terminal edge. *v* and *d* mark the ventral and dorsal aspect at the alveolar apex.
- v.* Ventral aspect of the same specimen, showing the obtuse and irregular groove.
- l'* and *d'*. Lateral and dorsal views of a young example, more lengthened than in the seniors.
- s'*. Section across the alveolar chamber.
- s''*. Section at the alveolar apex, showing great excentricity.
- s'''*. Section nearer the apex of guard, showing less excentricity of axis.



Fig 40



s''



Fig 41

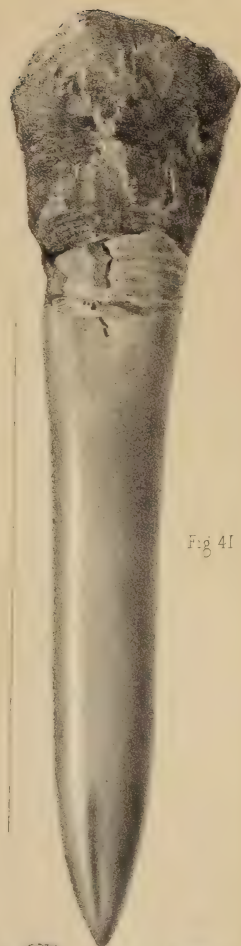


Fig 42.



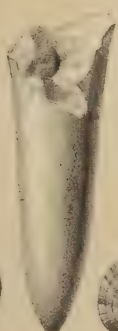
s



v'



s'



z



s''



l'



s'''



d'



EXPLANATION OF PLATE XVII.

FIG.

43. BELEMNITES VOLTZII, n. s. (Upper Lias, Whitby.)

- l.* Lateral view of a symmetrical specimen.
- d.* Dorsal aspect of the same.
- v.* Ventral aspect of the same.
- l''.* Lateral view of a larger specimen.
- φ'.* Phragmocone, seen laterally.
- φ''.* The same, seen dorsally.
- s'.* Transverse section at the alveolar apex.
- s''.* „ „ near the apex of the guard.

44. BELEMNITES VENTRALIS, n. s. (Upper Lias, Robin Hood's Bay.)

- l.* Lateral view ; the apex worn.
- d.* Dorsal view of the same.
- v.* Ventral aspect of the same.
The striation is seen on each.
- s'.* Transverse section at the alveolar apex.
- s''.* „ „ further along the guard.
- s'''.* „ „ near the apex of the guard.

45. Younger examples, with unworn apices. The points are striated. (Upper Lias, Whitby.)

- l.* Lateral view.
- v'.* Ventral view, to show the rather long groove.
- v''.* Another specimen, in which only the faintest trace of such a groove appears.
These three figures are not very easily distinguished from the young of
Belemnites vulgaris.

Fig. 43.



Fig. 45.



Fig. 44.

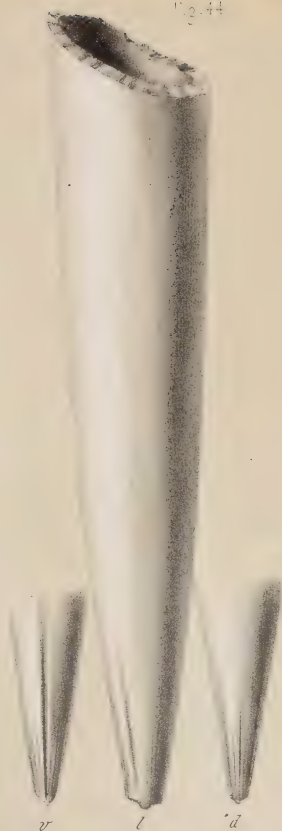
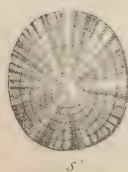
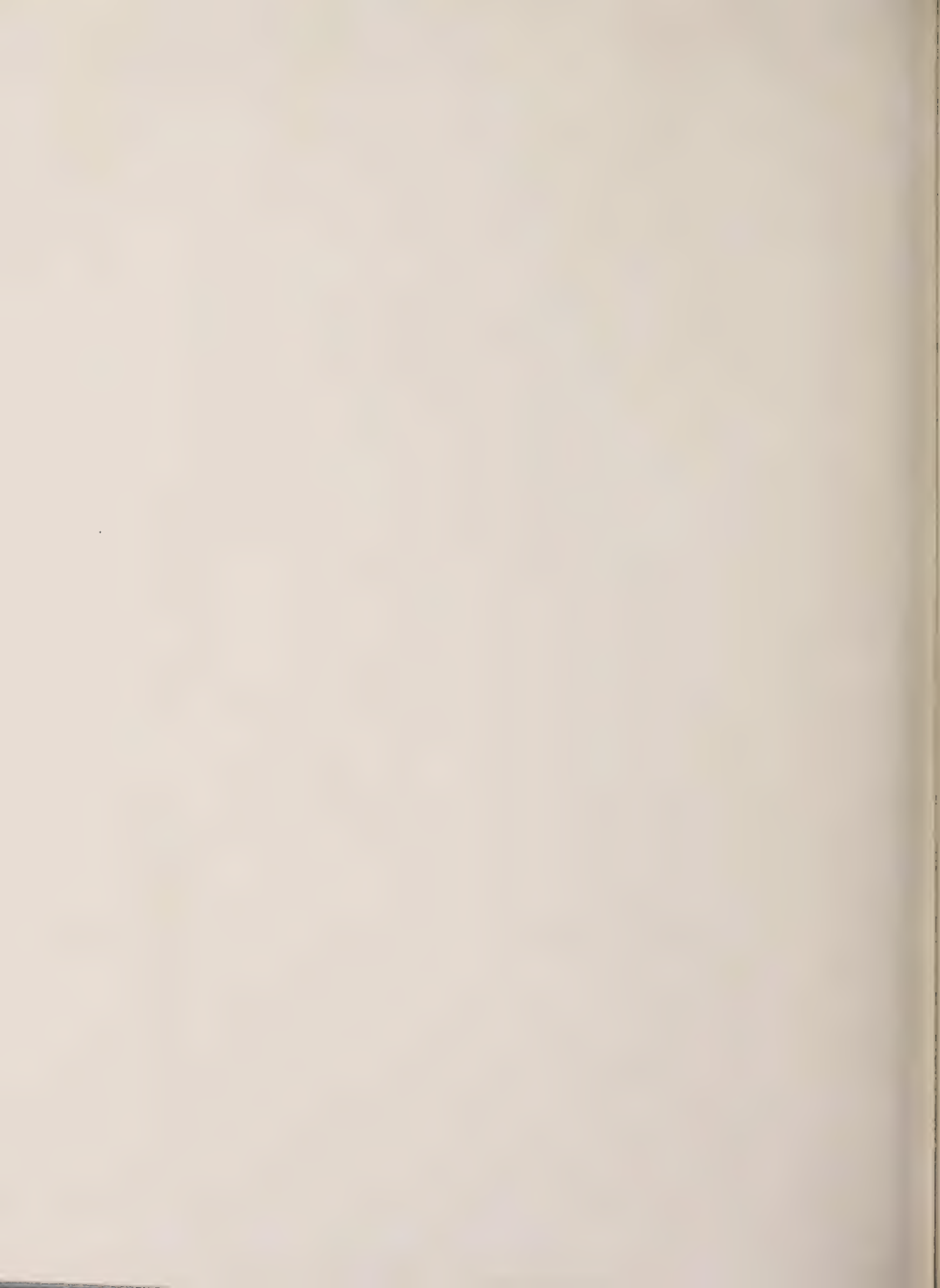


Fig. 44.





EXPLANATION OF PLATE XVIII.

FIG.

46. BELEMNITES INORNATUS, n. s. [Without ventral groove.] Blue Wick, Robin Hood's Bay.

l. Lateral view, showing the insertion of the phragmocone. Between *d* and *v* is the alveolar apex.

l''. Lateral view of a specimen in which the grooves and striæ are very obscure (worn).

s. Longitudinal section, showing the slightly arched phragmocone, covered by the conotheca, *in situ*.

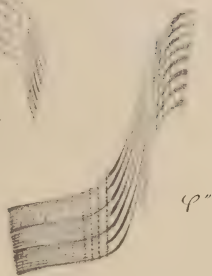
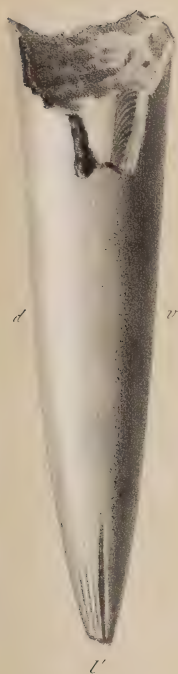
s'. Transverse section across the alveolar cavity.

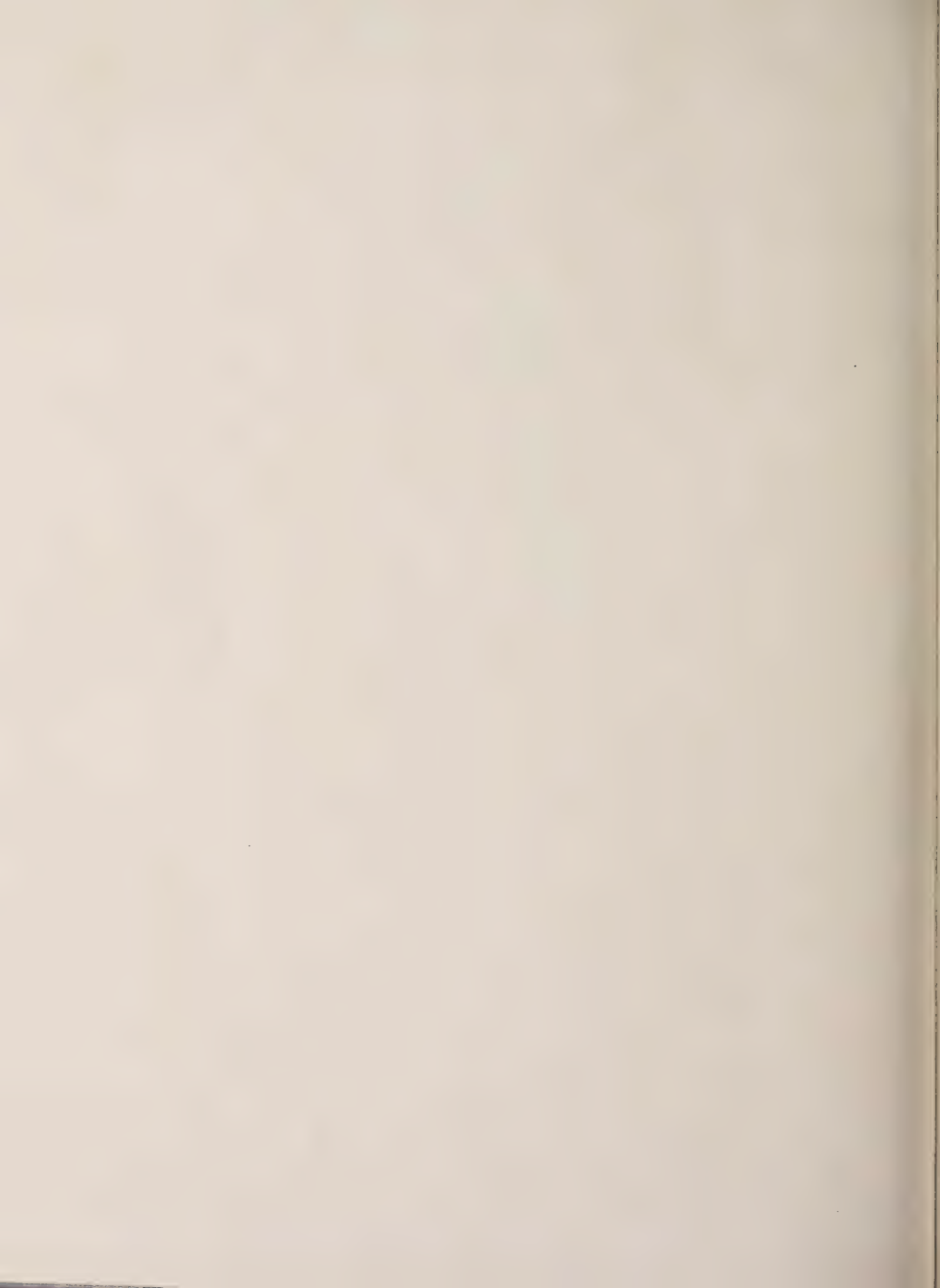
s''. " " at the alveolar apex.

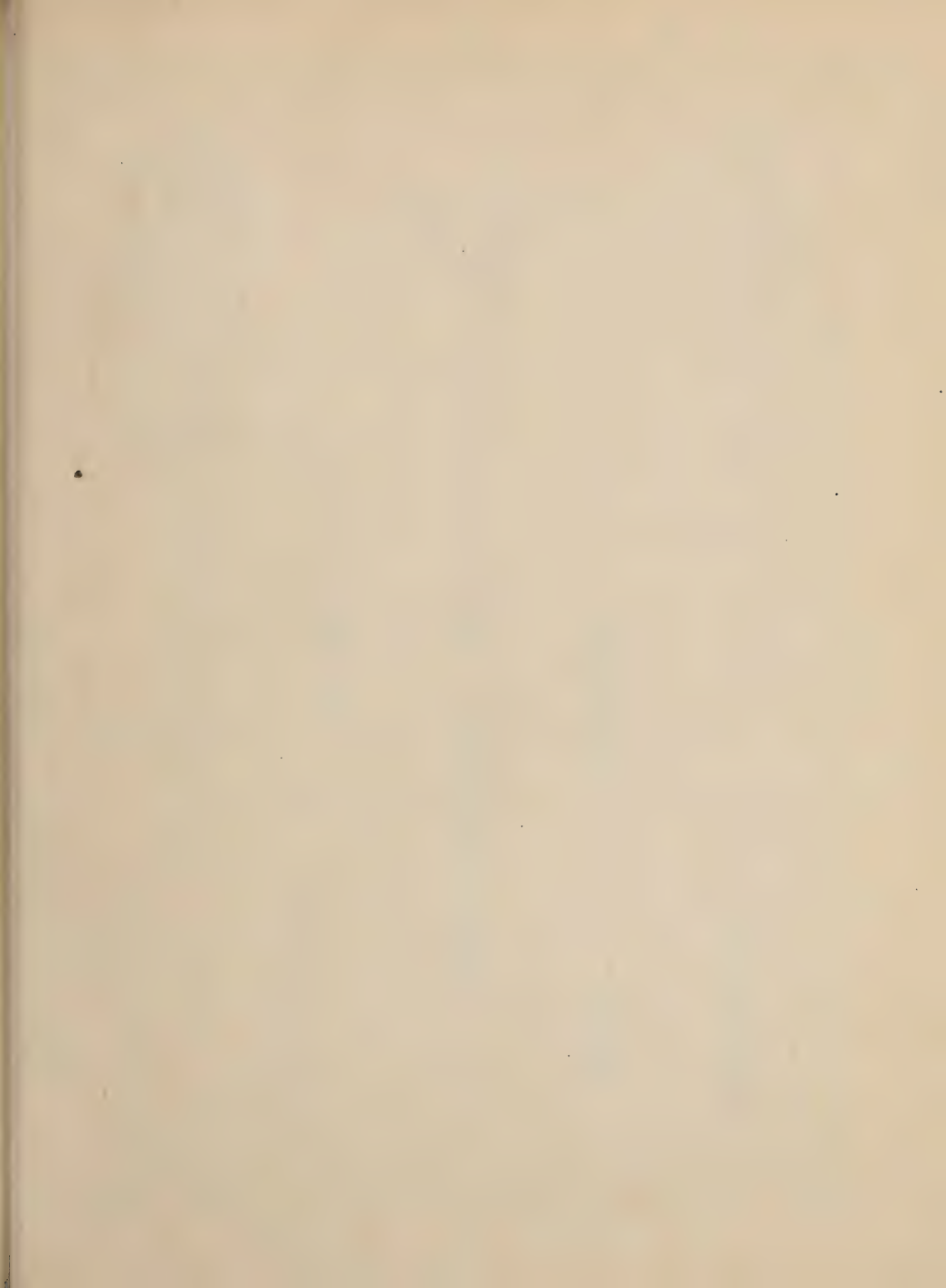
φ'. Portion of the conotheca, seen dorsally.

φ''. Portion of the same, seen laterally.

Fig. 46.







EXPLANATION OF PLATE XIX.

FIG.

47. *BELEMNITES LONGISULCATUS*. (Copied from Voltz's figure, 'Obser. sur les Bélemn.,' pl. vi, fig. 1.)

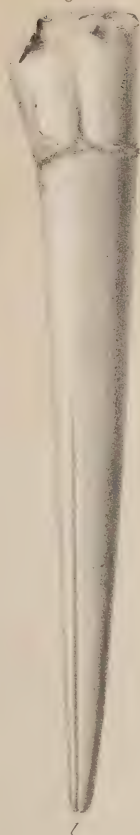
l. Lateral view.
d. Dorsal view.
v. Ventral view.

48. *BELEMNITES INÆQUISTRIATUS*. (From the Upper Lias of Whitby.)

l. Lateral view of a specimen in the Whitby Museum, "No. 454."
d. Dorsal aspect of the same.
v. Ventral aspect of the same.
v'. Enlarged view of the tripartite end.
s'. Shows the oval contour of the alveolar region, the ventral area being broadest.

49. *BELEMNITES SULCI-STYLUS*, n. s. (From Nailsworth [Sands].)

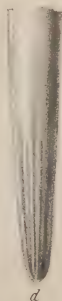
Fig 47.



l

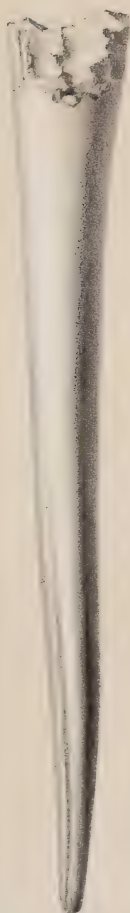


v



d

Fig 48



l



2r

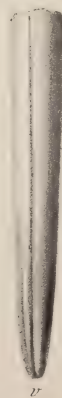
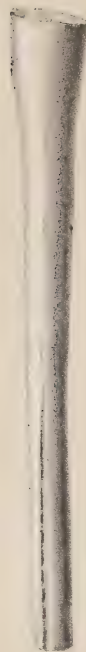


d

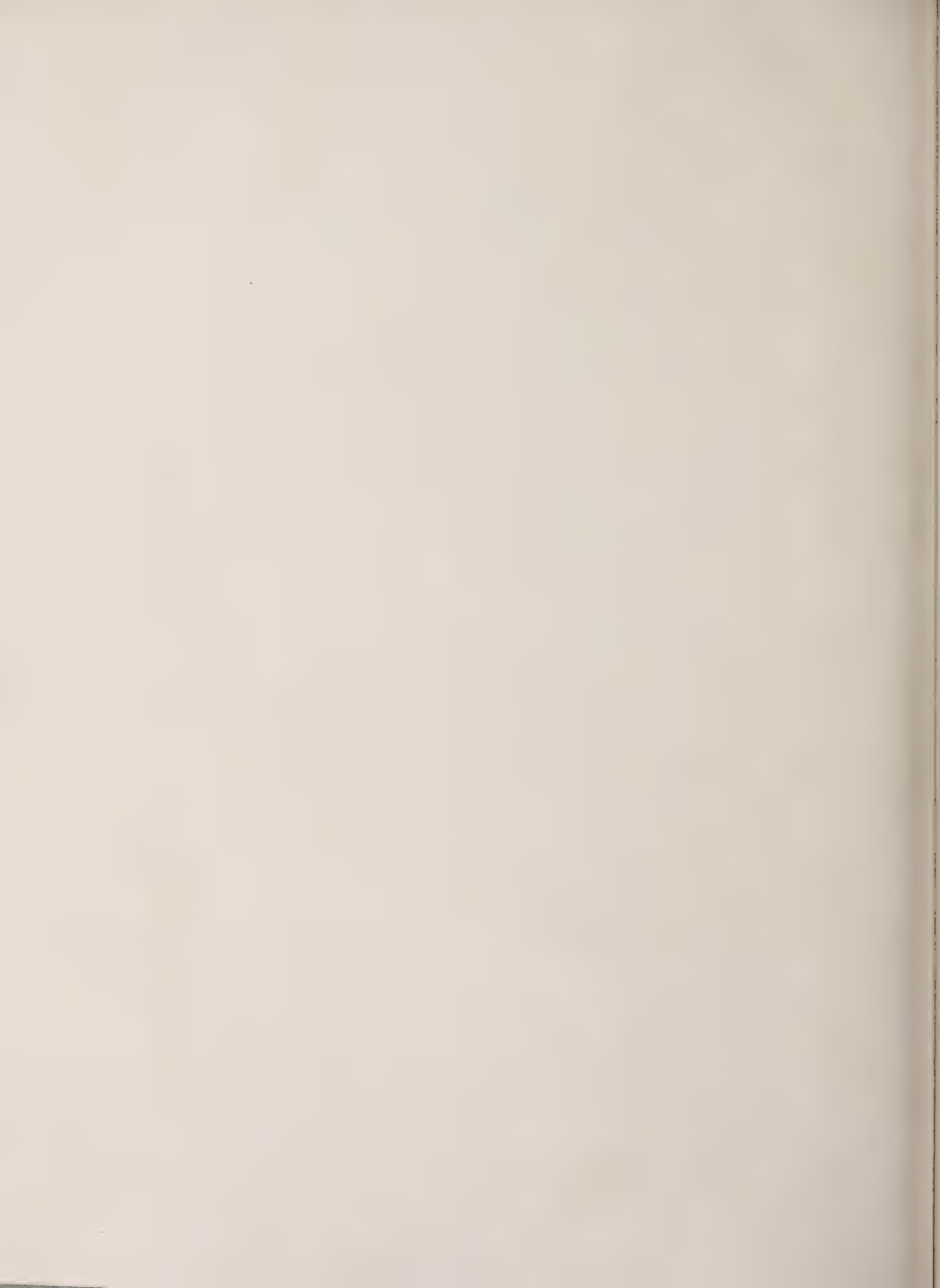


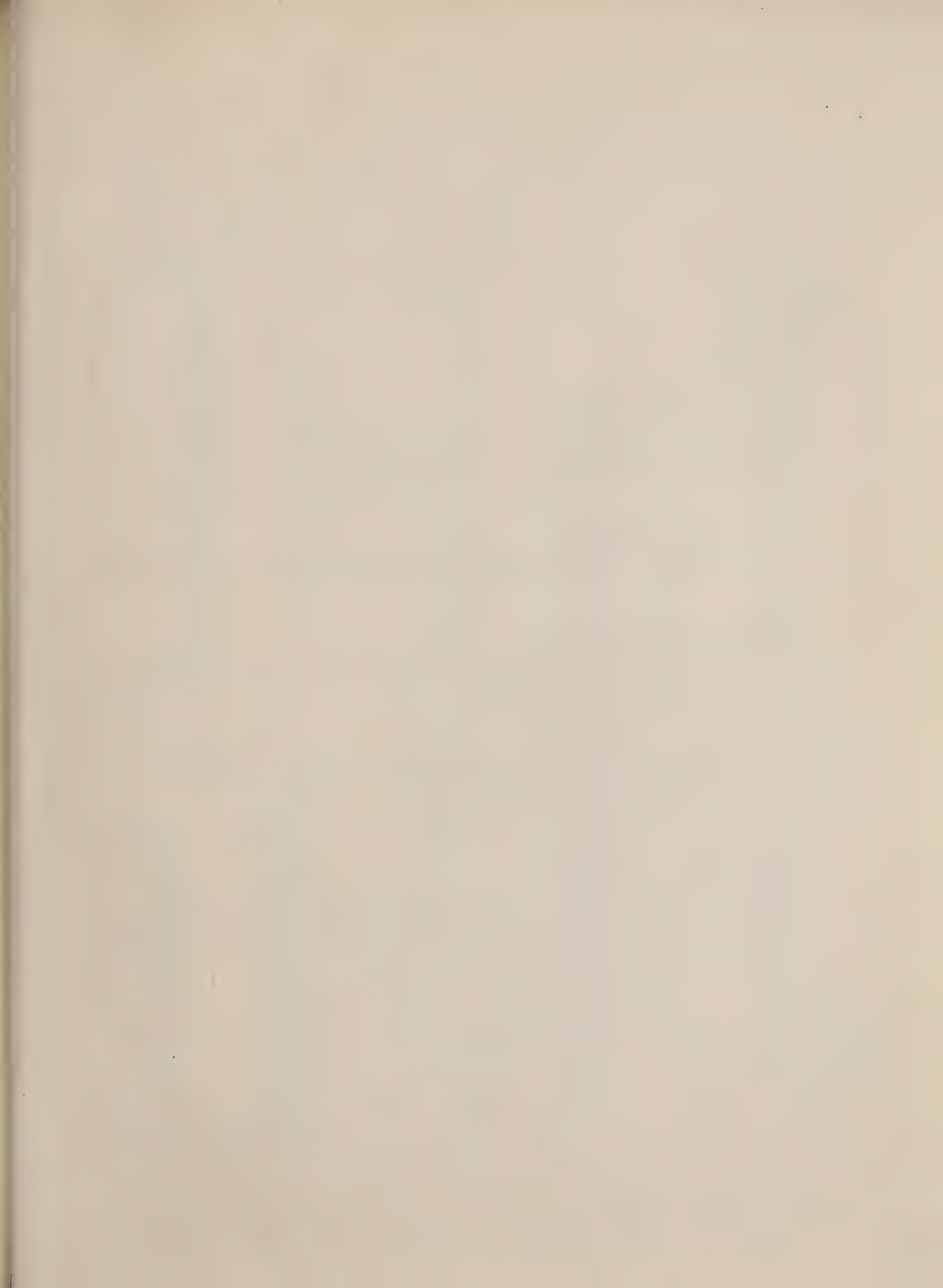
s

Fig 49



v





EXPLANATION OF PLATE XX.

FIG.

50. BELEMNITES ELEGANS.

- l.* Lateral view of a specimen in the Whitby Museum, "No. 967, Robin Hood's Bay, north side."
- l'.* Lateral view of a specimen in Collection of Prof. Phillips. Huntcliff.
- d, v.* Dorsal and ventral aspect of the same specimen.
- l''.* Lateral view of a specimen in the Whitby Museum, "No. 458, Robin Hood's Bay."
- s.* Transverse section.
- s.* Longitudinal section of a specimen in Prof. Phillips's Collection. Robin Hood's Bay.

51. BELEMNITES SCABROSUS, n. s.

- l.* Lateral view of a specimen in the Whitby Museum, "No. 976." From north side of Robin Hood's Bay.
- d, v.* Dorsal and ventral aspects.

52. P. *l.* BELEMNITES CYLINDRICUS. Lateral view of a specimen from Rosedale (near Staithes), in beds below the Jet-rock.

P. v, P. d. Ventral and dorsal view of the same.

52, M. *l.* BELEMNITES PAXILLOSUS.

- M. l.* Ventral aspect of a specimen from the marlstone of Ilminster, in the Collection of Mr. Moore. (The figure should have been marked *M. v.*; the slight seeming ventral groove near the apex is an accidental effect of the shading.)

Fig 50

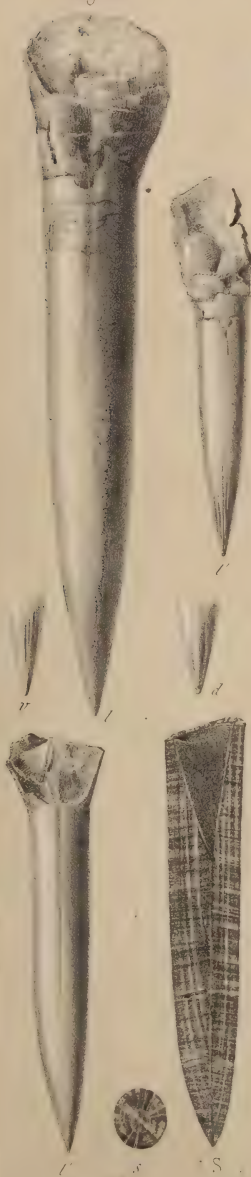


Fig 52

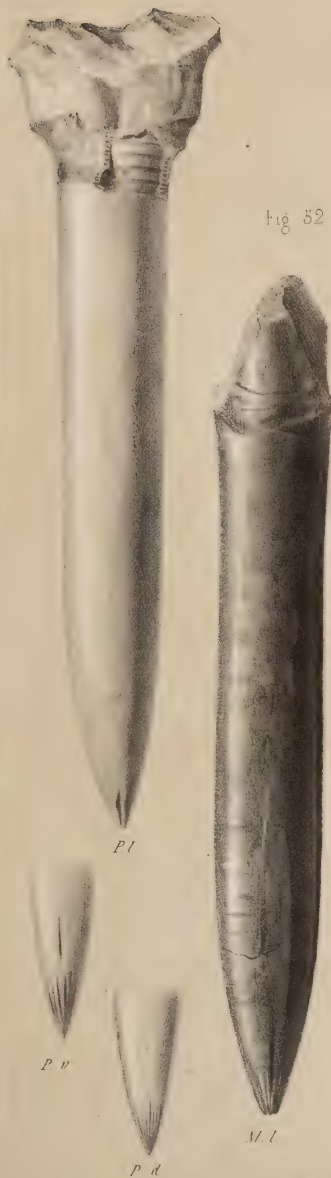
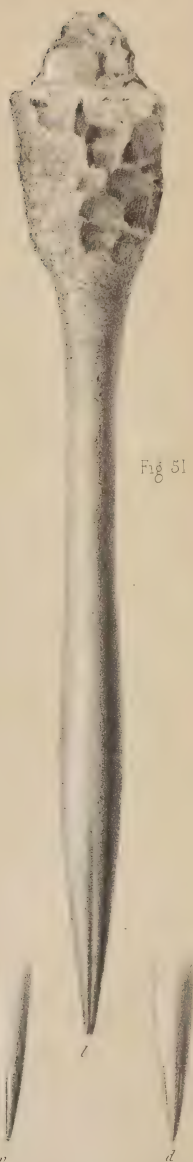


Fig 51









Paleontograph

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